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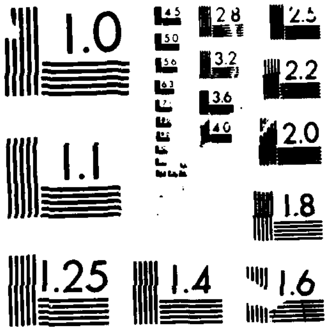

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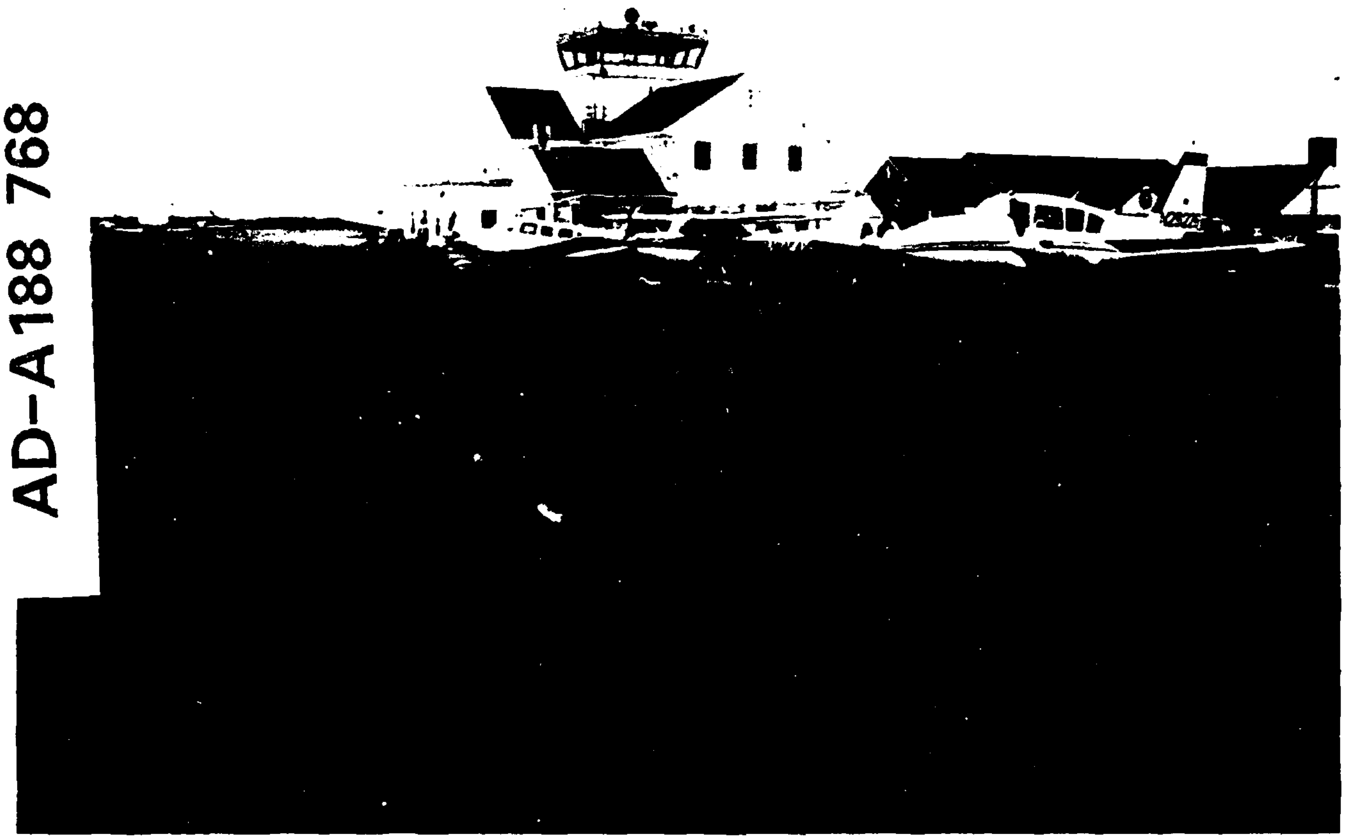
U.S. Department of Transportation

Federal Aviation Administration

The Demand for Single Engine Piston Aircraft



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16. Abstract

The general aviation manufacturing industry has experienced a continuous decline for the last six years, particularly in single engine piston aircraft, which dropped from 13,266 units shipped in 1979 to 985 in 1986. This decline has resulted from increasing costs, soaring product liability costs, overproduction in the peak years, and reduction in the number of student pilots, private pilots and flight schools.

The Federal Aviation Administration (FAA) is interested in the future of general aviation activity because it would impact workload and facilities needs. This report specifically addresses future impacts on Flight Service Stations.

The study includes a historical review of the industry, a survey of its current status, and an assessment of its future direction. It concludes that techniques for forecasting future activity must be adapted to the changing environment. With the reversal of past trends, traditional methods no longer produce valid results. Sales of single engine piston aircraft will increase only when the current surplus of low-time used aircraft is absorbed or becomes technologically obsolete. They are not expected to return to previous peaks due to an aging population, changing life styles, increasing urbanization, and the availability of commercial aviation. Flight Service Station (FSS) workloads are changing due to the changing nature of general aviation activity, as well as automation, consolidation, and changing responsibilities. New FSS workload measures are necessary to reflect these changes.

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This study was undertaken by the Federal Aviation Administration (FAA) to gain a better understanding as to the reasons for the continuing slump in the general aviation manufacturing industry, particularly, in single engine piston aircraft. It is the responsibility of the Office of Aviation Policy and Plans to forecast future FAA workload and the need for staffing and facilities. The data developed in this report provide information which should significantly improve the accuracy and validity of our general aviation forecasting models.

The FAA would welcome public comments concerning this report or the recommendations of the Contractor.

Ellen Kranidas

Ellen Kranidas
Director of Aviation Policy and Plans

THE DEMAND FOR

SINGLE ENGINE PISTON AIRCRAFT

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We would like to express our appreciation for the significant time and effort others put into helping us understand the complex dynamics of the single engine piston aircraft market and the variety of factors that have affected the industry. Without the help of the General Aviation Manufacturers Association, the Aircraft Owners and Pilots Association, and the manufacturers, operators, Flight Service Station personnel, and others listed in Appendix A, this report would be incomplete. The continuous advice and encouragement of Mr. Gene Mercer of the Office of Aviation Policy, FAA, and his staff also contributed to the results. Of course, any errors or misrepresentations remain the responsibility of the authors.

David Rubin and Regina VanDuzee

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EXECUTIVE SUMMARY

The general aviation manufacturing industry has had a continuous decline in aircraft deliveries for the last six years. This decline has been particularly evident for single engine piston aircraft, the majority of the fleet. Shipments dropped from a high of 13,266 in 1979 to 985 in 1986. The three major manufacturers, Beech, Cessna and Piper, have almost ceased production of single engine pistons. Increased manufacturing costs coupled with soaring product liability costs have driven prices up and discouraged innovation. Overproduction in the peak years created a surplus of low-time used aircraft which currently supplies the market. Numbers of student pilots, private pilots, flight schools and hours flown have also declined.

Such a continuing decline in the general aviation industry is of concern to the Federal Aviation Administration (FAA) because its responsibilities are affected by the number of aircraft in the general aviation fleet, number of pilots, and hours flown. Among these FAA responsibilities are estimating the future workload and the need for staffing and facilities, especially Flight Service Stations.

This study provides a historical review of the industry, a survey of its current status, and an assessment of its future direction. In addition, a chapter is devoted to consideration of Flight Service Stations, now undergoing major structural changes. They are being affected by changes in general aviation activity and changes resulting from automation, consolidation and private provision of Flight Service Station services. Techniques for

for forecasting such activity must be adapted to the changing environment.

With the reversal of past trends, traditional methods of forecasting using population, GNP and other economic variables no longer produce valid results. The first step of this study was to collect all applicable data on aviation activity and related economic and demographic measures as background information. Extensive interviews with knowledgeable people involved in all facets of general aviation were conducted. Heavy emphasis was placed on the information obtained in these interviews. In addition, substantial research was conducted on possible aircraft that may serve the single engine piston market in the future and advanced technologies that may improve safety and efficiency and lower production costs.

The report's findings may be summarized as follows:

- Sales will gradually increase at such time as the current surplus of low-time used aircraft is absorbed and older aircraft become obsolete.

- Sales would be favorably affected by the introduction of a technologically improved product that significantly decreases the cost of flying.

- Sales will never return to the peak of 1979-1981 unless a similar set of circumstances such as high inflation and an event such as the GI Bill, which encouraged entry of new pilots and put a time constraint on the period of eligibility, reoccurs. Historically, average annual demand has not exceeded 7000 to 9000 aircraft a year.

- The aging of the population, changing life styles, competition for the recreation dollar, increasing urbanization, and the availability of commercial air travel will continue to dampen single engine piston sales.

- Forecasts based on economic data should be supplemented by analysis of pilots as a percentage of the general population using census forecasts.

- Total cost of flying should be carefully monitored as a factor strongly affecting the rate of participation.

- Structural and technological changes in the Flight Service Station system will make changes in workload measures and forecasting methods necessary.

- Student pilots rely heavily on FSS services and a decrease in their numbers will lead to a disproportionate decrease in demand for flight services.

- Regional Airlines code sharing with major airlines are likely to use the services of the majors to file Flight Plans directly with the ARTCC rather than FSS's.

- Alternative workload measures should be considered to better describe the FSS's workload. If workload measures are changed, base data will have to be adjusted to facilitate forecasting.

- Automàtion, improved productivity and a continuing decline in general aviation activity will cause a decrease in demand for flight services over the next ten years.

INTRODUCTION

The single engine piston aircraft market is the base on which general aviation activity builds. Three-quarters of the aircraft in the fleet are single engine piston, and that's where involvement in flying starts. Two-thirds of general aviation flying hours are in single engine piston aircraft. New pilots are trained in single engine piston aircraft and work their way up through retractable landing gear and multi-engine piston to turbine aircraft. When the single engine market declines, it bodes ill for the future of general aviation. The production and sale of general aviation aircraft, avionics and other equipment and support systems such as flight schools, fixed base operators, finance, and insurance makes the general aviation industry an important contributor to the nation's economy, estimated at more than $15 billion annually.

Shipments of all types of general aviation aircraft increased steadily during the 1970's reaching a peak of 17,811 units in 1978. Since that time, there has been a dramatic decline in the shipments to 1495 in 1986. This report is focused on single engine piston aircraft where the decline has been even more pronounced. In 1979, 13,286 aircraft were delivered. That number declined to 985 in 1986. The decline in shipments of single engine piston aircraft that began in 1981 was presumed to be a recession related decline, and did not cause serious concern until 1983-84. Then the economy began to recover, but the downturn continued instead of reversing. The trend has continued through 1986, and the single engine piston industry today is nearly dormant. Historical linkage between growth in the general economy and population and single engine piston aircraft sales appeared to be no longer valid. A number of reasons have been advanced for this pattern, chief among them being rapid price increases, high interest rates and expensive fuel over the 1976 to 1986 time period. A portion of the price increases can be attributed to massive awards assessed against manufacturers in product liability lawsuits which triggered extreme increases in liability insurance premiums, driving up manufacturer's costs. Cessna, the world's largest producer of small aircraft, has ceased production of single engine piston aircraft. Beech and Piper are producing limited numbers of aircraft at the high end of the price and weight range. Nobody is producing the simple two seat basic trainer aircraft

Forecasts of shipments of single engine piston (SEP) aircraft, and forecasts of the general aviation activity that these aircraft generate have been overly optimistic for the last several years. Nobody correctly predicted the length or depth of the decline. Most forecasts, based on econometric measures that had worked well for years, have predicted growth instead of decline. It was felt that there was some basic change in the structure of the market to which the forecasting models were not responsive. The Office of Aviation Policy of the Federal Aviation Administration (FAA) contracted with COMSIS Corporation to investigate the SEP market and develop conclusions as to the structure of the market and ways to forecast its future.

The study was initiated with a data gathering effort that concentrated on primary sources, particularly personal interviews. Representatives of all segments of the SEP industry; manufacturers, distributors, users and insurers were visited. Those visited are listed in Appendix A. The interviews resulted in an understanding of the complexity of the situation and the variety of factors that have had an impact on the sale of single engine piston aircraft. Based on that understanding, data were assembled and analyzed for a variety of elements, which included: single engine piston shipments, new and used aircraft prices, aviation gasoline prices and recreational vehicle shipments. Statistical analysis lead to the conclusion that the use of the statistical relationships for predictive purposes cannot be recommended, as they only explain the past changes in the structure of the single engine piston market, and it is not logical to project these changes into the future.

The report is organized in four main sections. The nature of the changes that have occurred are discussed in the first section, the historical background of the industry. The current status of the industry is discussed in the second section, and future possibilities in the third. The fourth section specifically addresses the changing nature of Flight Service Station activity.

CHAPTER ONE

HISTORICAL BACKGROUND OF THE GENERAL AVIATION INDUSTRY

In order to understand the structural changes that have occurred in the general aviation industry, historical data were examined and related.

AIRCRAFT SHIPMENTS AND VALUE

Shipments of all types of general aviation aircraft, which have been cyclical since World War II increased steadily during the 1970's, reaching a peak of 17,811 units in 1978 and declining thereafter as shown in Table 1-1 and Figure 1-1. For the past seven years the decline has been dramatic. It began in 1979 when single engine piston aircraft (SEP) deliveries were off 8 percent and by 1982 had spread to all categories of aircraft. The value of shipments continued to climb until 1980 due to increasing sales of multi-engine aircraft (Figure 1-2). The focus of this report is single engine pistons, shipments of which dropped sharply from a high of 13,286 in 1979 to 8,640 in 1980 to 985 in 1986, a decrease of more than 92 percent over the seven year period. The drop in SEP deliveries in 1986 was exacerbated by the fact that Beech limited production to one model, and both Cessna and Piper suspended production while they sold inventory and resolved product liability problems.

Meanwhile, dollar value of all general aviation shipments, fueled by both increasing sales of larger aircraft and inflation, continued an upward climb to a peak of more than $2.9 billion in 1981, then declined steadily to $1.26 billion in 1986, a 55 percent drop over the four-year period. However, for three years

TABLE 1-1
GENERAL AVIATION AIRCRAFT - SHIPMENTS AND BILLINGS
1946-1986

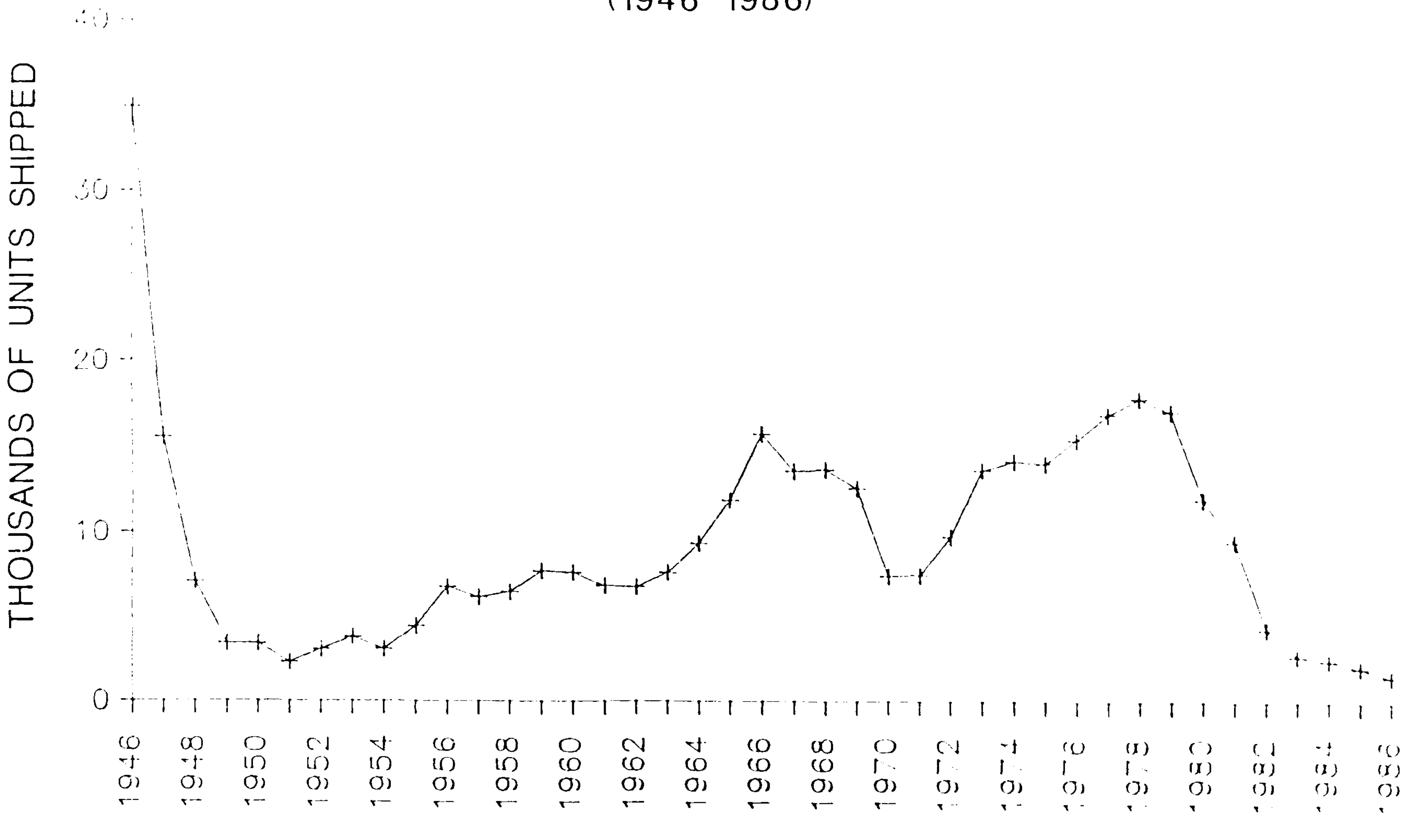
Year	Units Shipped	Factory Billings (000,000)
1946	35,000	$110.0
1947	15,594	57.9
1948	7,037	32.4
1949	3,405	17.7
1950	3,386	19.1
1951	2,302	16.8
1952	3,058	26.8
1953	3,788	34.4
1954	3,071	43.4
1955	4,434	68.2
1956	6,738	103.7
1957	6,118	99.6
1958	6,414	101.9
1959	7,689	129.8
1960	7,588	151.2
1961	6,778	124.3
1962	6,697	136.8
1963	7,569	153.4
1964	9,336	198.8
1965	11,852	318.2
1966	15,768	444.9
1967	13,577	359.6
1968	13,698	425.6
1969	12,591	638.8
1970	7,402	337.0
1971	7,464	321.5
1972	9,774	557.6
1973	13,646	828.1
1974	14,166	909.4
1975	14,056	1,032.9
1976	15,451	1,225.5
1977	16,904	1,488.1
1978	17,811	1,781.2
1979	17,048	2,165.0
1980	11,877	2,486.2
1981	9,457	2,919.9
1982	4,266	1,999.5
1983	2,691	1,469.5
1984	2,438	1,698.1
1985	2,029	1,430.0
1986	1,495	1,260.0

Note: Factory billings are in current dollars
Source: General Aviation Manufacturers Association (GAMA)

FIGURE 1-1

ANNUAL SHIPMENTS OF ALL G.A. AIRCRAFT

(1946-1986)

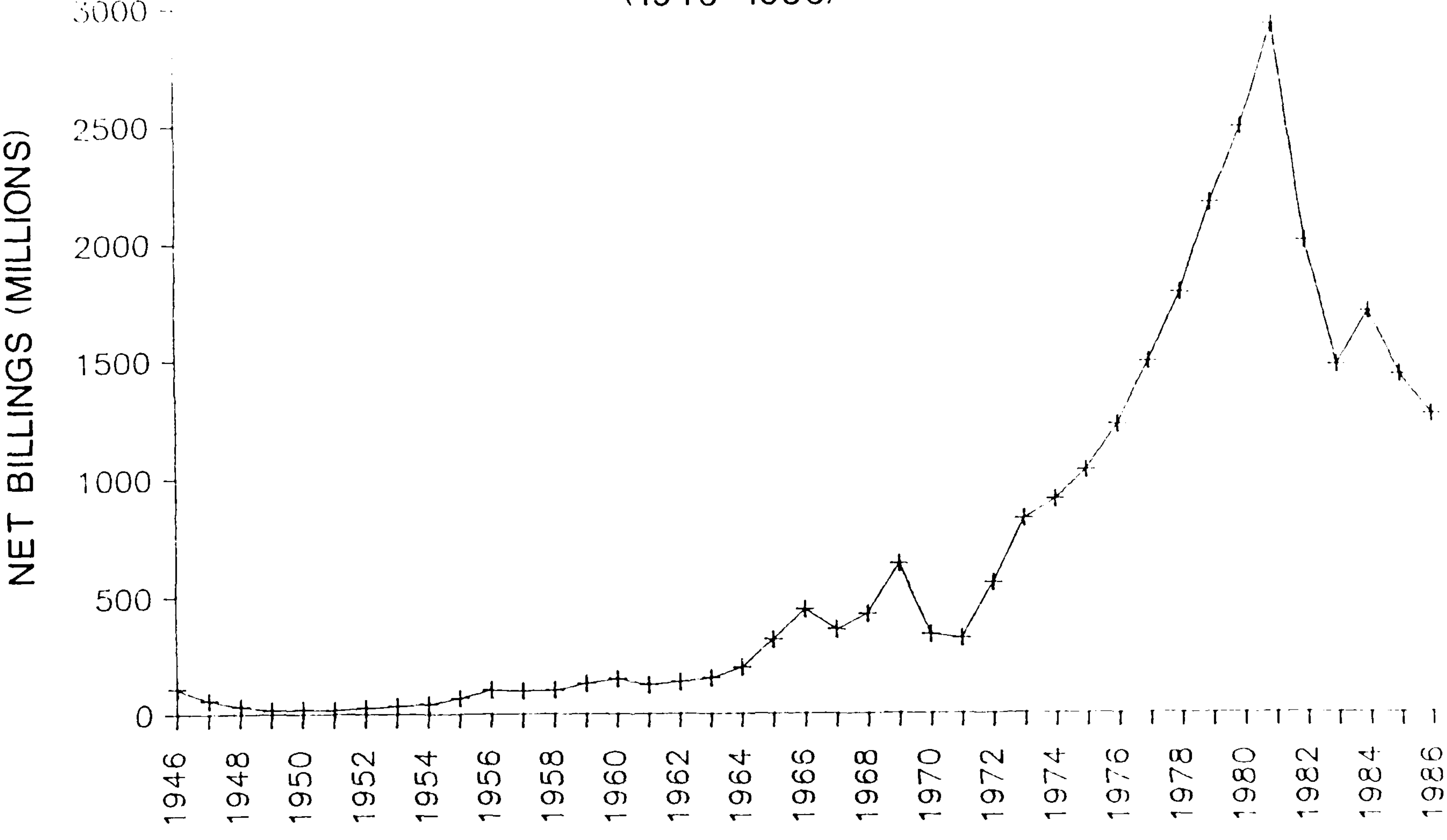


SOURCE: GAMA

FIGURE 1-2

ANNUAL BILLINGS/ALL G.A. AIRCRAFT

(1946-1986)



SOURCE: GAMA

after the number of units shipped started falling off, the dollar value of shipments actually continued to rise.

EXPORTS AND IMPORTS

Aircraft exports (Table 1-2) over the last decade followed the pattern of total shipments, peaking in 1979. The percent of total units shipped ranged from 20 to 30 percent until 1983 when a rapidly rising dollar increased prices for foreign buyers and exports dropped 56 percent from the previous year. The downward trend reversed in 1985 when there was a small increase in units shipped. 1986 showed a strong increase from 354 to 439, attributed by the General Aviation Manufacturers Association (GAMA) to the dollar's decline in relation to other currencies. However, this is a far cry from the almost 4,000 shipped in 1979. Single engine piston shipments also peaked in 1979 at about 3,000 and the declined to 199 in 1984. 1985 saw a small upturn to 208 and another in 1986 to 271. The export market has never been the focus of the manufacturer's marketing efforts, perhaps because it is a small percentage of the U.S. market and competition from non-U.S. aircraft has been limited. As more small aircraft become available from foreign sources, they may replace U.S. made products and limit overseas markets.

Imports of small aircraft have never been a factor in the U.S. market. A total of 105 SEP's have been imported since 1981. However, that number did increase from 9 in 1981 to 46 in 1985. Aerospatiale's Trinidad and Tobago are the major contenders at this time.

TABLE 1-2

U.S. GENERAL AVIATION AIRCRAFT

Exports

Year	Units Exported	Percent of Total Production	Factory Net Billings (Millions)	Percent of Total Dollars
1972	2,254	23.1%	137.9	24.7%
1973	3,530	25.9	230.2	27.8
1974	4,248	30.0	287.5	31.6
1975	3,512	25.0	308.1	29.8
1976	3,539	22.9	331.2	27.0
1977	3,611	21.4	354.5	23.8
1978	3,612	20.3	486.7	27.3
1979	3,995	23.4	600.9	27.8
1980	3,555	29.9	756.4	30.4
1981	2,270	24.0	749.0	25.7
1982	1,162	27.2	650.2	32.5
1983	513	19.1	316.5	21.5
1984	336	13.8	261.0	15.4
1985	354	17.4	230.0	16.2
1986	439	29.4	330.4	26.2

Exports by Type

Year	Single Engine	Multi-Engine	Turboprop	Turbojet
1972	1,715	455	55	29
1973	2,674	732	58	66
1974	3,371	732	75	70
1975	2,680	644	122	66
1976	2,704	669	114	52
1977	2,835	594	126	56
1978	2,712	652	166	82
1979	2,942	774	181	98
1980	2,565	635	245	110
1981	1,546	363	259	102
1982	718	227	135	82
1983	298	119	66	30
1984	199	82	24	31
1985	208	65	53	28
1986	271	71	66	32

Source: GAMA

SHIFT IN THE MARKET

During this period of declining sales and production, a shift in the market took place. Sales of single engine piston aircraft as a percent of total sales declined from about 80 percent in 1978 to 66 percent in 1986. At the same time, sales of the more expensive turboprops and jets increased as a percentage of units sold from 3 and 1 percent, respectively, in 1978 to 17 and 8 percent in 1986. The shift to increased production of turboprops and jets, which helped cushion manufacturers during the industry decline, has important implications for the future production of small general aviation aircraft in the U.S. and the future of personal and recreational flying (Figures 1-3 and 1-4).

REASONS FOR MARKET BEHAVIOR

During the course of the study, a number of reasons for the boom in the market in the late 1970's and the subsequent slump were advanced by the aviation experts interviewed. It appears from hindsight that the extreme growth from 1977 through 1979 was an anomaly, not a continuation of normal growth. A number of factors were involved. The flight training benefits of the GI Bill were about to expire. Eligible students rushed to get their training before the expiration date. Manufacturers, encouraged by buoyant sales, continued production at high rates building inventory, which was pushed out to dealers. Prices of new aircraft escalated rapidly with prices of used aircraft tracking the new. High prices of used aircraft made it possible to upgrade to new with very little capital outlay and to obtain

FIGURE 1-3

SINGLE ENGINE BILLINGS AS A PERCENT OF TOTAL G.A.

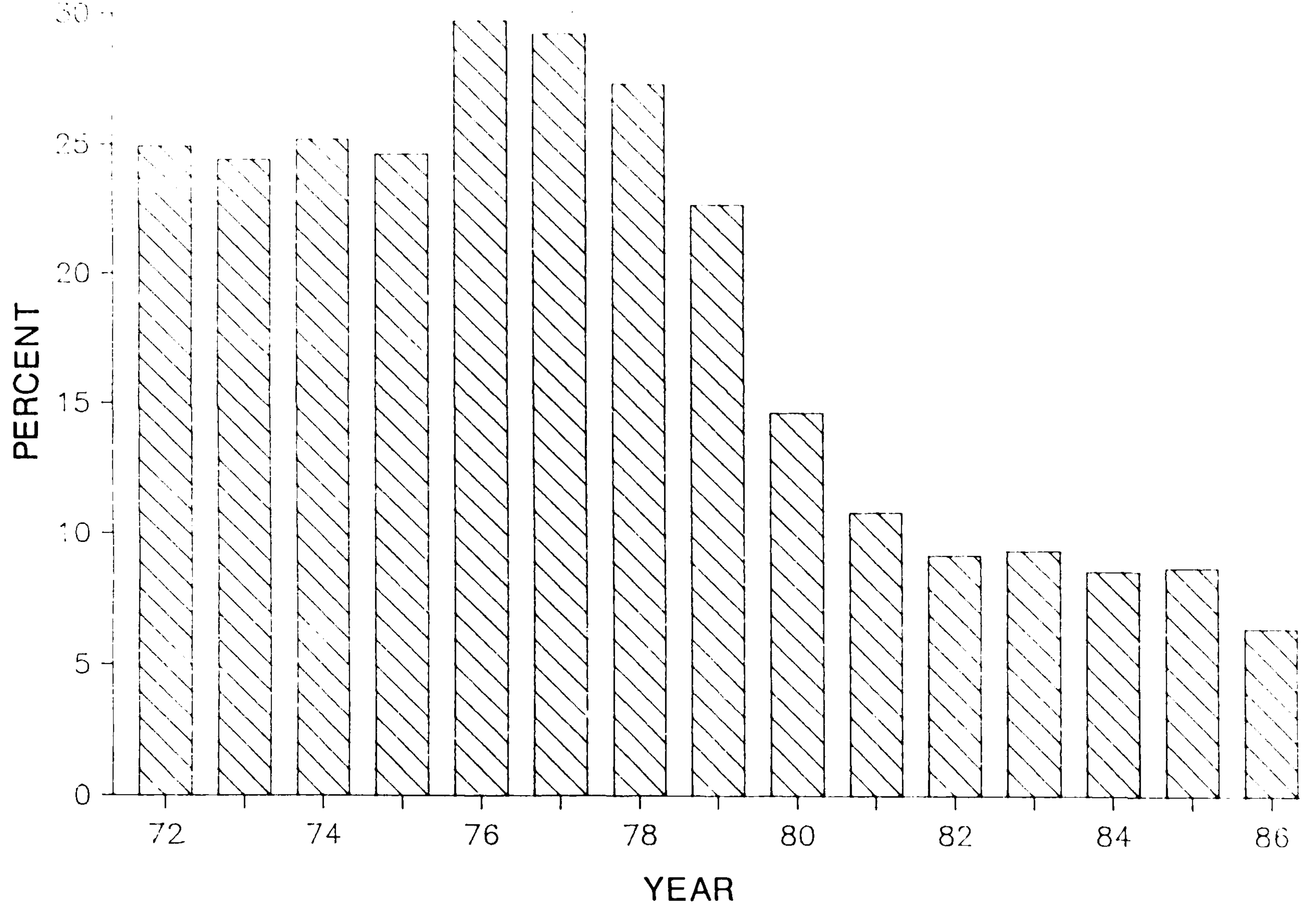
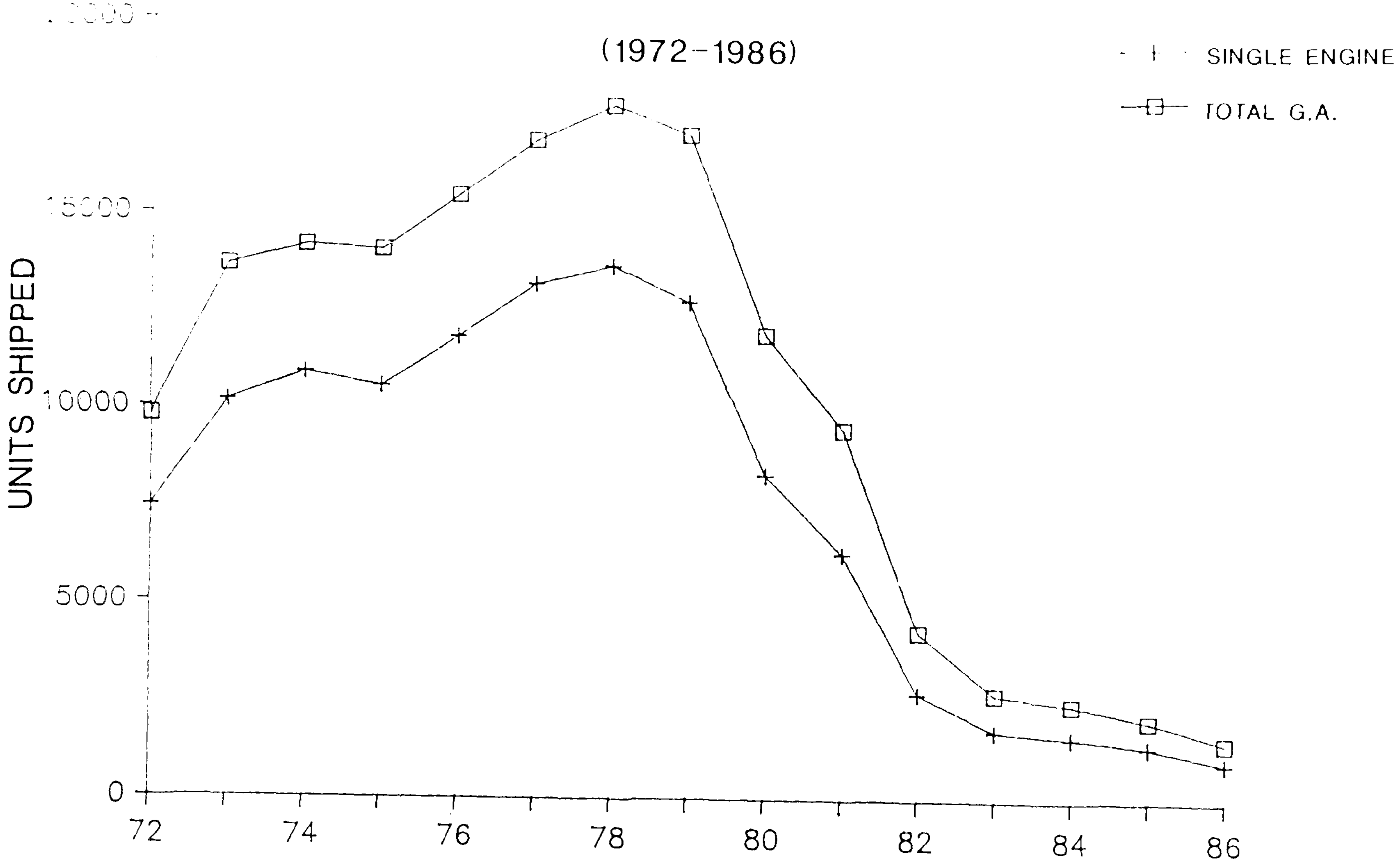


FIGURE 1-4

ANNUAL SHIPMENTS OF G.A. AIRCRAFT

(1972-1986)



SOURCE: GAMA

investment tax credit and rapid depreciation tax advantages as well.

The beginning of the market decline was probably triggered by the recessionary period that began toward the end of 1979. However, the national economy began to recover by the end of 1982 but shipments of general aviation aircraft did not follow. There was a large supply of new and used aircraft available, and real prices of aircraft had increased substantially. High interest rates pushed up financing costs and operating costs, particularly fuel, increased as well. Technical improvement in small aircraft was limited, reducing the incentive to purchase new models. During the period from 1976 to 1979, when demand appeared to be unlimited, the manufacturers had deemphasized single engine piston promotion and concentrated on the promotion and production of expensive jets and turboprops with more profit potential. Much of the advertising promotion for SEP had been aimed at potential new pilots, including free first flights and lessons. These programs were dropped as the market declined.

NEW AIRCRAFT PRICES

Prices of single engine piston aircraft have escalated rapidly since 1978 as illustrated in the sample below.

Aircraft	1978 Price	1985 Price	1985 Price for Used 1978 Model
Beech Sierra 24B	$58,900	$132,170	$27-30,000
Cessna Skylane	47,600	101,696	29-35,000
Cessna Skyhawk B	31,850	67,725	15-18,500
Piper Warrior	29,930	66,200	12-20,000

TABLE 1-3

SINGLE ENGINE PISTON AIRCRAFT - SHIPMENTS AND VALUES

1964-1986

Year	Number of Aircraft Shipped	Value of Shipments ($000,000)	Unit Cost* of Aircraft	Active Fleet
1964	7,812			76,144
1965	10,023			81,153
1966	13,226			88,659
1967	11,530			96,124
1968	11,539			103,807
1969	10,193			108,704
1970	5,603			109,643
1971	5,910			109,256
1972	7,438	$139	$18,688	120,446
1973	10,140	202	19,921	126,217
1974	10,884	229	21,040	131,932
1975	10,532	254	24,117	137,011
1976	11,803	364	30,840	136,600
1977	13,167	435	33,037	144,800
1978	13,651	486	35,602	149,300
1979	12,693	490	38,604	160,700
1980	8,283	365	44,066	168,435
1981	6,268	315	50,255	167,898
1982	2,697	183	67,853	164,173
1983	1,739	137	78,781	166,247
1984	1,592	145	91,080	171,922
1985	1,369	124	90,511	164,385
1986	985	80	81,218	N/A

[1]Excludes agricultural aircraft.

[2]Factory net billings in current dollars.

[3]Factory net billings ÷ units shipped.

Sources: Active Fleet - Federal Aviation Administration
All other data - Aerospace Facts and Figures 1985-1986.

A recent Beech survey indicates that price is a leading factor in the buyer's purchase decision. A study done for Cessna on the Cessna 172 Skyhawk indicated that the average price elasticity of demand between 1960 and 1985 was 5.96, but that under current market conditions, between 1982 and 1985, at the extreme upper portion of the demand curve, the elasticity has been 22.31.[1] During this period, the number of aircraft deactivated has remained fairly small, with more aircraft reactivated than deactivated in some years. As a result, the size of the single engine piston fleet has continued to grow or leveled off (Figure 1-5).

Table 1-3 lists the average manufacturer's price of single engine piston aircraft computed on the basis of total shipment value and units sold for the years 1972 through 1986, as assembled by GAMA. Figure 1-6 illustrates the changes. Figure 1-7 shows the average annual growth rate of the Consumer Price Index (CPI) and prices of SEP. The bar graph in Figure 1-8 highlights the yearly difference in growth rate of the CPI and the average price of SEP aircraft. From 1975 until 1985, the price of a single engine piston aircraft rose at a faster rate than the consumer price index (CPI) in every year except 1975 and 1979. The years 1976, 1982, 1983 and 1984 showed substantial differences. The trend reversed in 1985 and 1986. In 1986 the average manufacturer's price declined to $81,218 from the 1985

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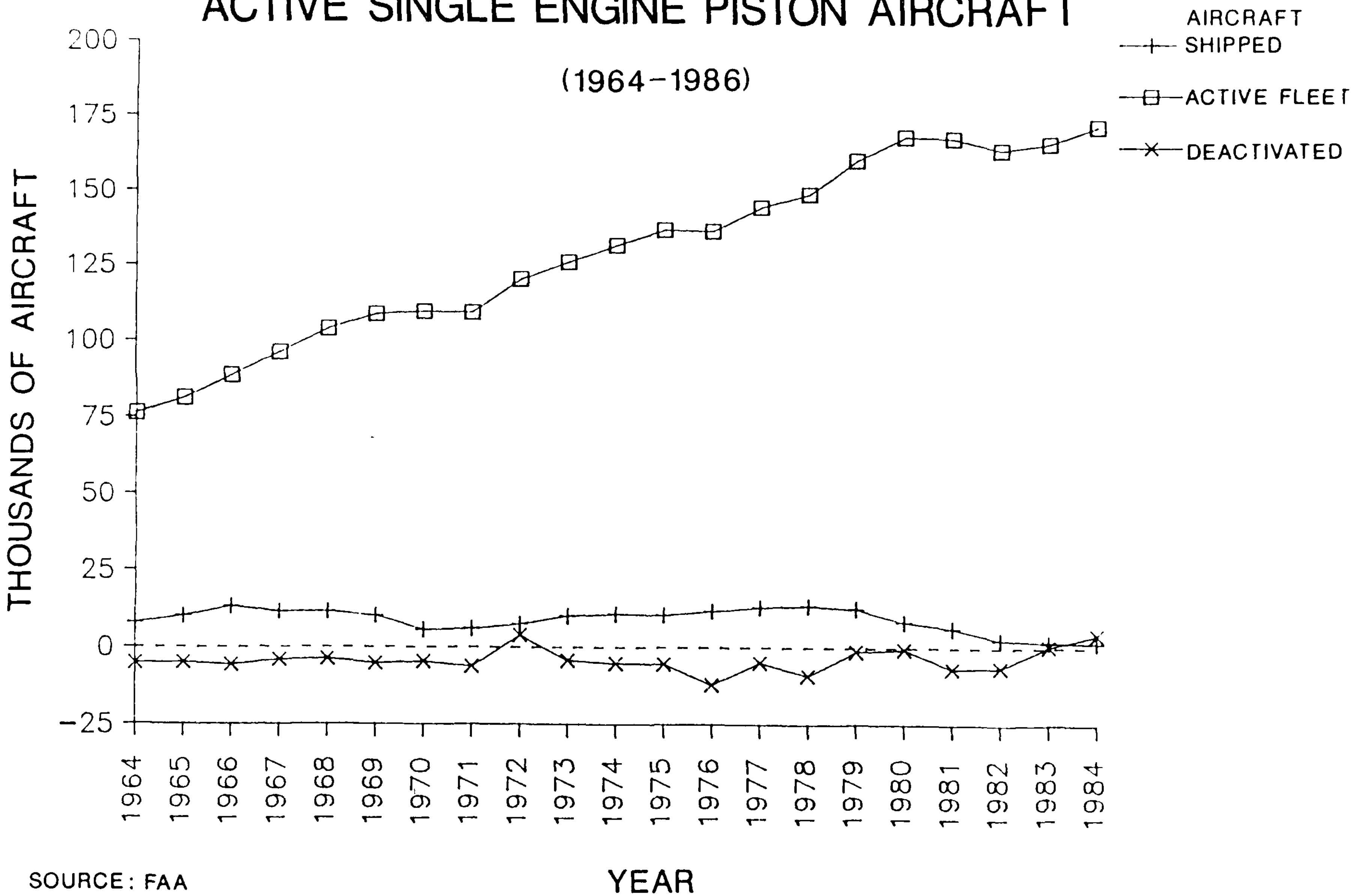
[1]McDougall, Gerald S. and Cho, Dong W., **The Demand for the Cessna Skyhawk Aircraft**, The Center for Business and Economic Research and the Institute for Aviation Research and Development, Wichita State University, Wichita, KS, May 1986.

FIGURE 1-5

ACTIVE SINGLE ENGINE PISTON AIRCRAFT

(1964-1986)

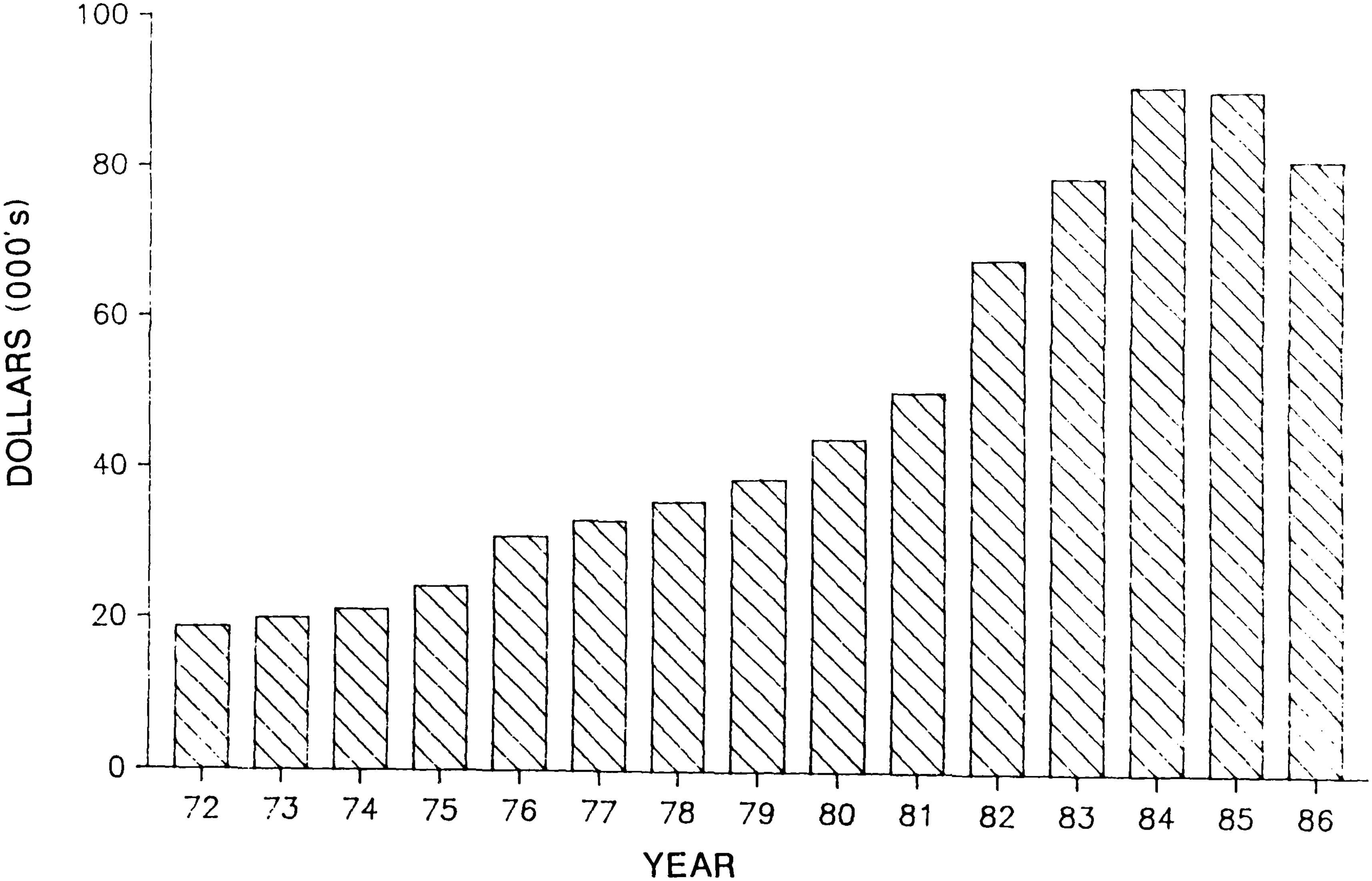


SOURCE: FAA

NOTE: DEACTIVATED= LAST YEAR'S FLEET + SHIPMENTS - CURRENT YEAR

FIGURE 1-6

UNIT COST OF SINGLE ENGINE AIRCRAFT



NOTE: EXCLUDES AGRICULTURE AIRCRAFT

FIGURE 1-7

GROWTH RATE OF CONSUMER PRICE INDEX
AND SEP UNIT COST
(1972–1986)

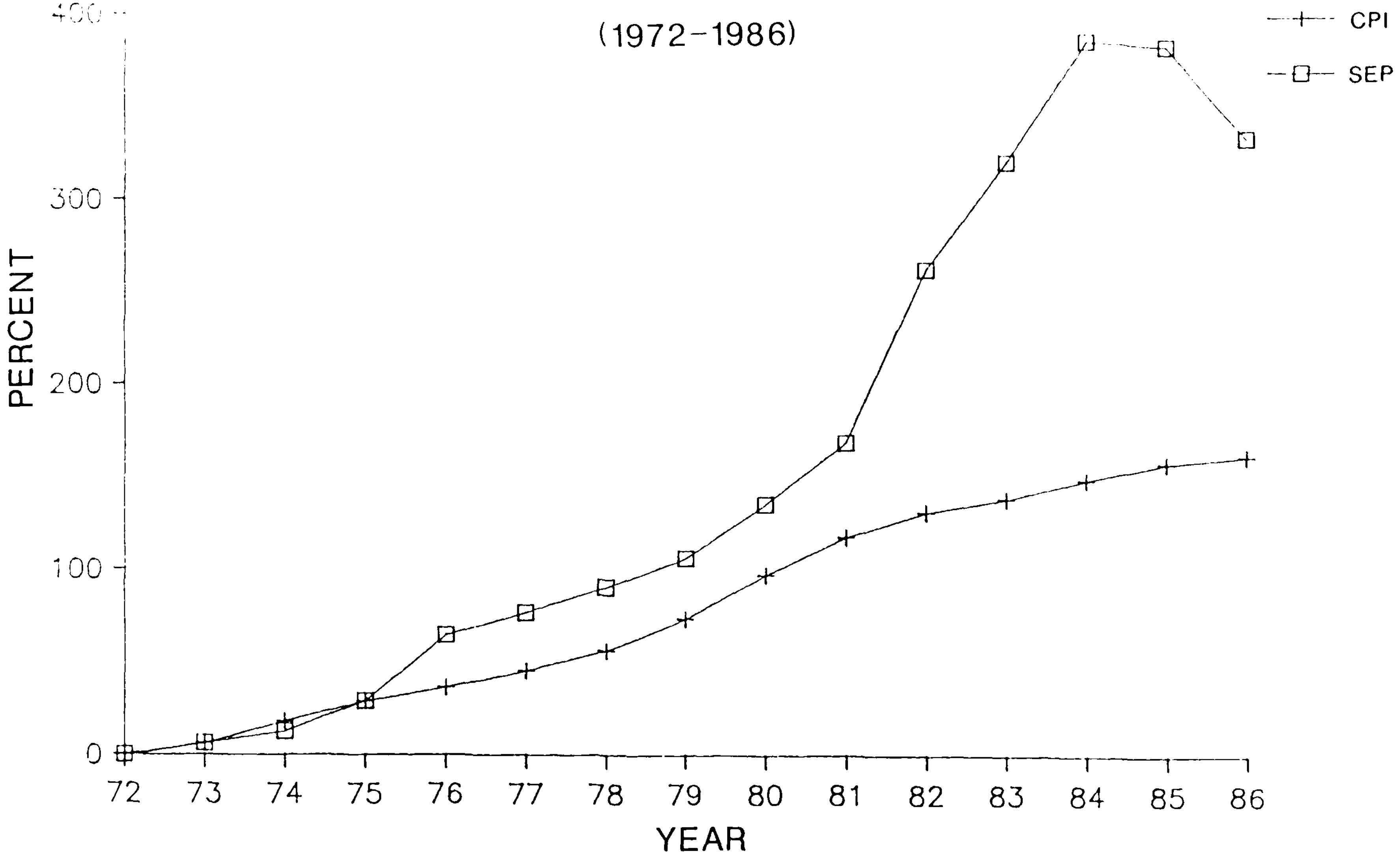
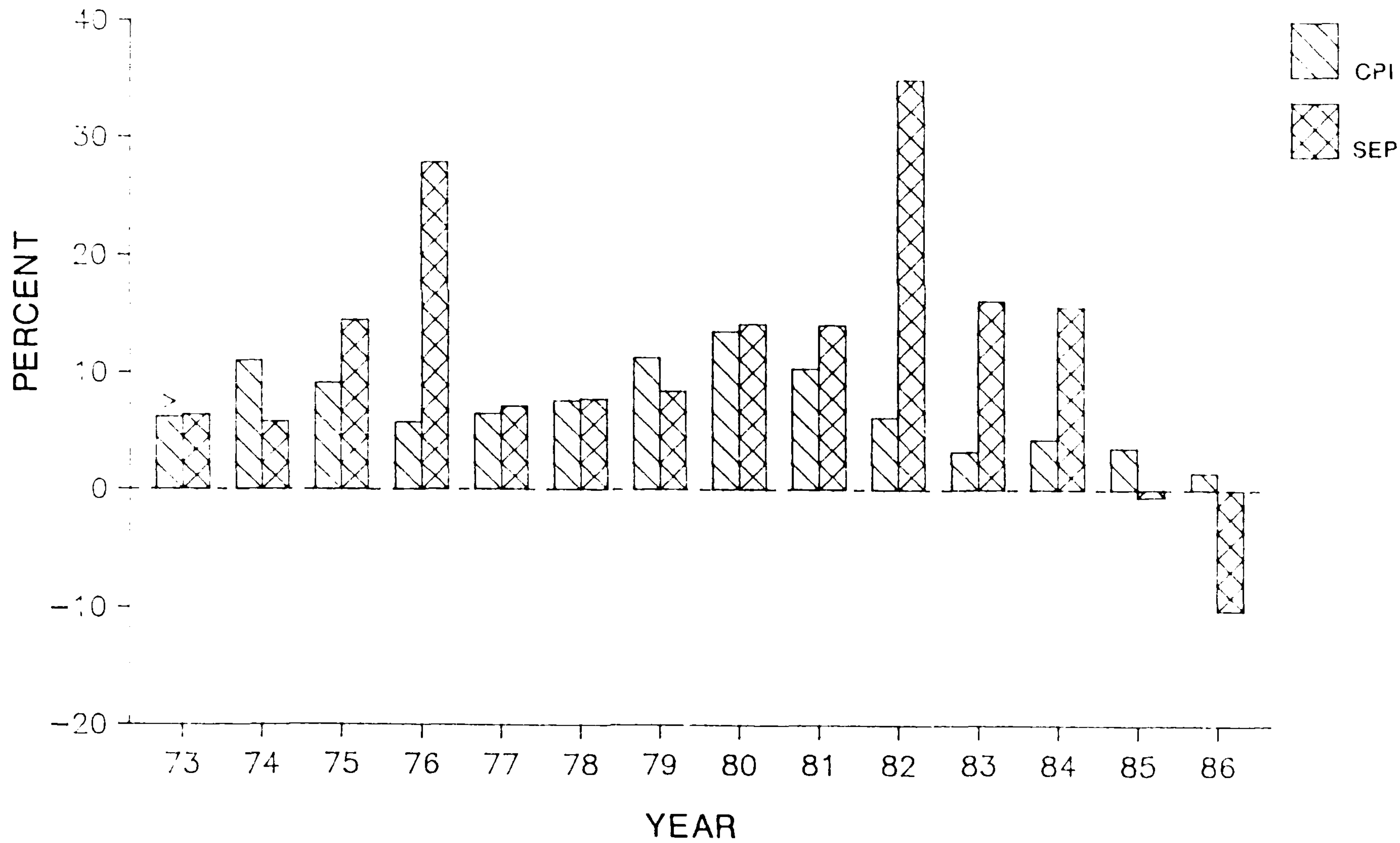


FIGURE 1-8

ANNUAL PERCENT CHANGE OF CPI AND SEP COST



price of $90,551. Upon investigation with GAMA, it appears that there were two reasons for this drop. The smaller number of aircraft shipped allows a more careful calculation of the total value of shipments and considerable price discounting took place in 1986 to clear inventories. Included in Appendix B are tables showing the new retail prices of single engine piston by model with a technical description of each aircraft, and average retail price by weight groups.

USED AIRCRAFT PRICES

Over the period from 1978 to 1986, prices of popular models of used aircraft have held up well. Appendix C gives year by year detail on prices of selected models. Cessna 182 Skyhawk 1968-72 models sold at about an average price of $13,750 in 1978 and $13,200 in 1986. A seven year old 1979 Beech Bonanza 33 was selling for $86,000 in 1986 compared to a price when new of about $110,000 equipped. Prices were supported by an underlying inflation and the substantial increases in the prices of new aircraft during this period. Given the minor differences between older and newer models of the same aircraft, there was little incentive to purchase a new aircraft.

PRICES OF AVIONICS

In order to look at prices changes for avionics separately from aircraft prices, a ten year time series of prices was constructed for six pieces of equipment suitable for installation on single engine piston aircraft. Prices for distance measuring equipment, emergency location transmitters, transponders, VHF navigation receivers, VHF communication transceivers, and VHF navigation receiver/communications transceivers were collected for the years 1976 through 1986.

It was not possible to obtain historical or current sales data for each of these items. Therefore, the average yearly price of a number of models made by several different manufacturers was computed. In the process of computing the average price, some of the most expensive items were eliminated since it is unlikely they would be installed on a single engine piston aircraft. For example, King Radio communication transceivers KTR 9100A at $7,882 and KTR 908 at $6710, which cost over $4000 more than any other model, were not included. Table 1-4 presents item prices, average prices, annual growth rates, year to year price changes, and growth rates of the Consumer Price Index for comparison for the years 1976 through 1986. Figure 1-9 illustrates the comparison.

Although there is considerable variation in year to year prices, avionics prices generally increased less than the CPI for the same ten year period. For example, the average annual growth rate for DME's was higher than the CPI growth rate in only one year, 1978. By 1986, the average annual growth rate for prices over the 10 year period was 3.72 percent compared to 6.73 percent for the CPI. This situation is generally true for the all the equipment except for emergency locater transmitters (ELT's), the least costly item. The price increase may be partially explained by the fact that when ELT's were first required by the FAA, a number of manufacturers jumped into the market to equip the large active fleet of GA aircraft, creating tough price competition.

TABLE 1-4

AVIONICS EQUIPMENT PRICING 1976-1986
(In Dollars)

Emergency Locator Transmitter

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Dorne & Margolin, Inc.	DMELT 6		$199	$206	$248	$248	$248	$248				
	DMELT 8								$248	$252	$320	$360
	DMELT 8.5									616	754	754
DME Corp.	RBL-9					590	685	685	685	685	799	799
Emergency Beacon Corp.	EBC-102	$104	104	129	149	175	200	225	225	280	310	341
	EBC-102A	138	138	160	200	230	241	275	300	350	385	422
	EBC-202A	184	184	200	275	319	329	360	380	430	476	523
	EBC-202B	220	220	249	300	350	349	385	430	470	517	569
	EBC-302	242	242	242	300	350	380	420	470	540	621	683
	EBC-302V	265	265	299	360	420	450	496	550	630	725	797
Martech, Inc.	EAGLE EB-2BCD	160	175	175	205	245	270	310		350	370	
	DOLPHIN EB-2BW	280	385	385	424	488	538	605		690	725	
	SURVIVAL KIT EB-2B		271	271	459							
	MAKO-B-EPIRB				190							
Narco Avionics	ELT-10	159	189	210	225	245	270		310	325	350	350
Pointer, Inc.	3000	160		175	175	225	239	260	260	260	260	260
	3000-2		165	190	190	190						
Average		**191**	**211**	**222**	**264**	**313**	**350**	**388**	**386**	**452**	**509**	**533**
Average Annual Growth Rate			10.58%	7.85%	11.38%	13.15%	12.85%	12.52%	10.55%	11.36%	11.48%	10.79%
Average Annual Growth Rate CPI			6.45%	7.05%	8.44%	9.69%	9.82%	9.20%	8.32%	7.81%	7.33%	6.73%
Total Growth Rate			10.58%	16.31%	38.19%	63.92%	82.99%	102.98%	101.78%	136.48%	166.01%	178.54%
Total Growth Rate CPI			6.45%	14.60%	27.51%	44.75%	59.77%	69.56%	75.01%	82.46%	88.97%	91.73%
Annual Change in Price			10.58%	5.18%	18.81%	18.63%	11.63%	10.92%	(.59%)	17.20%	12.49%	4.71%
Annual Change in CPI			6.45%	7.66%	11.26%	13.52%	10.37%	6.13%	3.22%	4.26%	3.57%	1.46%

Source: **AOPA Pilot**, June 1976-1986.

TABLE 1-4 (Cont'd)

AVIONICS EQUIPMENT PRICING 1976-1986
(In Dollars)

Distance Measuring Equipment

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Bendix Avionics Division	DME-2030		$4,040	$4,650	$4,650	$4,400	$4,395	$4,650	$4,030	$4,500		
Cessna Aircraft Co.	RTA-476A	$3,295	3,495	3,695	3,695	3,850	4,095	4,300	4,140	4,140	$4,140	
1984 to date models are	RTA-477								4,850	4,850	4,850	$5,362
manufactured by Sperry	C-876A,RTA-876A		3,995	3,995	3,995	4,150	4,395					
	1077B							7,350	9,185	9,185	9,185	10,399
Collins Radio	DME-451			3,980	3,980	3,980	4,250	4,890	4,890	5,695	5,695	6,960
EDO-Aire	RT-888/CA-888	3,995	3,995	3,995	3,995							
King Radio Corp.	KN 61	2,095	2,095									
	KN 62A			2,895	3,100	3,175	2,995	2,995	3,195	3,350	3,520	3,680
	KN 63				3,850	3,850	4,245	4,500	4,850	5,095	5,350	5,650
	KN 64							2,500	1,975	2,150	1,550	1,825
	KN 65A	3,045	3,045	3,395								
	KNS 80			4,895	5,665	6,100	6,830	7,600	7,600	6,200	6,425	6,715
	KDM 705A	5,595	4,195	4,600								
Narco Avionics	DME-190	2,730	2,895	3,295	2,750	2,895						
	DME 890						2,495	2,595	1,995	2,195	2,150	1,695
	DME-891									2,195	2,195	2,250
	DME-195	3,295	3,695	3,695	3,925	3,695	4,195	4,295				
Average		**3,436**	**3,494**	**3,917**	**3,961**	**4,011**	**4,211**	**4,568**	**4,671**	**4,505**	**4,506**	**4,948**
Average Annual Growth Rate			1.71%	6.78%	4.85%	3.94%	4.15%	4.86%	4.49%	3.45%	3.06%	3.72%
Average Annual Growth Rate CPI			6.45%	7.05%	8.44%	9.69%	9.82%	9.20%	8.32%	7.81%	7.33%	6.73%
Total Growth Rate			1.71%	14.02%	15.27%	16.73%	22.55%	32.94%	35.95%	31.12%	31.15%	44.03%
Total Growth Rate CPI			6.45%	14.60%	27.51%	44.75%	59.77%	69.56%	75.01%	82.46%	88.97%	91.73%
Annual Change in Price			1.71%	12.10%	1.10%	1.26%	4.99%	8.48%	2.27%	(3.55%)	.02%	9.82%
Annual Change in CPI			6.45%	7.66%	11.26%	13.52%	10.37%	6.13%	3.22%	4.26%	3.57%	1.46%

TABLE 1-4 (Cont'd)

AVIONICS EQUIPMENT PRICING 1976-1986
(In Dollars)

Transponders

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Bendix Avionics Div.	TR-661A-6104	$595										
	TR-661A-6103	650										
	TPR-2060		$730	$820	$720	$775	$850	$900	$1,125	$1,400		
Cessna Aircraft Co.	RT-359A	645	695	695	700	750	800	825	875	875	$910	$952
1984 to date models are	RT-459A	760	795	795	800	825	875	900	950	950	985	1,030
manufactured by Sperry	RT-859A	1,095	1,195	1,295	1,300	1,395	1,450	1,590	1,900	1,900		
	SXP-1060										2,100	2,195
Collins Radio	TDR-950L	620	620	620	665							
	TDR-950	670	670	670	720	720	795	895	895	1,195	1,195	1,515
EDO-Aire	RT-777	645	695	695	745							
	RT-787					745	745	896	1,095	1,095	1,095	1,195
	RT-667	695	695	695	845	896	896	995				
	RT-887		945	945	995	995	995	995	1,195	1,195	1,295	1,495
General Aviation Electronics	BETA/5000	595	595	625	650							
King Radio Corp.	KT 78A	595	570	600	655	690	745					
	KT 76A	650	595	645	695	730	775	810	855	895	940	965
	KT 79							2,300	2,300	2,415	2,535	2,680
	KXP 755	2,325	1,900	1,950	2,150	2,256						
Narco Avionics	AT-50A	595	595									
	AT-150		595	625	665	695	740	825	855	855	935	975
	AT-200				1,450	1,450						
RCA Avionics Systems	Primus XPD	2,460	2,765									
Sperry Flight Systems	TP-114B	2,308	2,280	2,500	2,280							
Terra	R 250			475	475	475	495	550	695	795	1,095	1,095
Average		**994**	**996**	**916**	**971**	**957**	**847**	**1,040**	**1,158**	**1,234**	**1,309**	**1,410**
Average Annual Growth Rate			.23%	(4.02%)	(.77%)	(.94%)	(3.15%)	.76%	2.21%	2.74%	3.10%	3.56%
Average Annual Growth Rate CPI			6.45%	7.05%	8.44%	9.69%	9.82%	9.20%	8.32%	7.81%	7.33%	6.73%
Total Growth Rate			.23%	(7.88%)	(2.29%)	(3.72%)	(14.81%)	4.64%	16.52%	24.12%	31.65%	41.83%
Total Growth Rate CPI			6.45%	14.60%	27.51%	44.75%	59.77%	69.56%	75.01%	82.46%	88.97%	91.73%
Annual Change in Price			.23%	(8.09%)	6.07%	(1.47%)	(11.51%)	22.83%	11.35%	6.51%	6.07%	7.73%
Annual Change in CPI			6.45%	7.66%	11.26%	13.52%	10.37%	6.13%	3.22%	4.26%	3.57%	1.46%

TABLE 1-4 (Cont'd)

AVIONICS EQUIPMENT PRICING 1976-1986
(In Dollars)

VHF Communications Transceivers

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Cessna Aircraft Co.	1038A		$4,880	$4,880	$4,880	$5,075	$5,500	$6,350	$7,295	$7,295	$7,595	$7,938
Collins General Aviation Div.	VHF-250		1,045	1,045	1,275	1,275	1,665					
	VHF-251	$1,315	1,315	1,375	1,595	1,395	1,895	2,195	2,195	2,395		
	VHF-20A	3,620	3,620	3,725	3,660	3,805	4,480	4,905	7,320	8,175	8,175	9,815
	618M-3	3,420	3,628	3,904								
	VHF-253							2,195	2,195	2,395	2,395	2,955
Comco	733	595	595	595	595	595	595	595	595	745		
	732	715	790	790	790	870						
	727 MOBILE						1,030	1,030	1,030	1,030	1,030	1,030
	727 BASE						1,130	1,130	1,130	1,130	1,130	1,130
Edo-Aire	RT-551	845	895	915	995	1,055						
	RT-551A	945	995	1,015	1,095	1,160	1,260	1,380	1,495	1,550	1,660	1,795
	RT-661	945	995	1,015	1,095	1,160						
	RT-661A	1,045	1,095	1,115	1,195	2,220	1,360	1,480	1,595	1,660	1,730	1,975
Genave	ALPHA/6		495	495	495	569	569	569	569	569	569	569
	ALPHA/10	540	540	650	683							
	ALPHA/12					785	785	890	890	890	890	890
	ALPHA/720		840	995	1,045	1,200	1,200	1,300	1,300	1,300	200	1,200
	ALPHA/100						900	1,000	1,000	1,000	900	
King Radio Corp.	KY 92			995	1,045	1,150	1,240	1,580	1,510	1,590	1,675	1,775
	KY 195B	1,090	1,090	1,250			1,500	1,600				
	KY 196			1,595	1,755	1,755	1,860	1,995	2,155	2,260	2,375	2,515
	KY 197			1,595	1,755	1,755	1,860	1,995	2,155	2,260	2,375	2,515
	KTR 905	3,445	3,445	2,595	2,830	2,830						
	KTR 9100A	3,762	3,233	3,428	3,599	3,850	4,236	4,572	5,876	6,516	7,232	7,882
	KTR 909							5,250	5,670	5,955	6,335	6,710
	KA 93						1,920	2,080	2,250	2,365	2,485	2,690
	KA 94						1,420	1,580	1,700	1,785	1,875	2,085
Martech, Inc.	150-3A		600	600			1,885	2,118	N/A	2,450	2,860	
	150-2A		620	620	975	1,075	1,570	1,765	N/A	2,050	2,200	
Mentor Radio Co.	TR-12	396	396	432	484	484	532	532	532	532	596	596
	TR-12-PORT	576	576	612	688	688	756	756	756	756	840	840
	M 360	880	880	880								
	M 360 PORT	1,296	1,296	1,296								
	TR-12F-BASE						704	704	704	704	784	784
Narco Avionics	COM 120		1,150	1,265	1,345	1,375	1,595	1,825	1,895	2,095	2,195	2,250
	COM 120/20				1,345	1,495	1,795	1,995	2,050	2,250	2,295	2,350
	COM-810						1,695	1,825	1,750	1,995	2,150	2,150
	COM-811						1,695	1,825	1,750	1,995	2,150	2,150

TABLE 1-4 (Cont'd)

AVIONICS EQUIPMENT PRICING 1976-1986
(in Dollars)

VHF Communications Transceivers (Cont'd)

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Sperry Flight Systems	CT-107B	$3,800	$3,760	$4,000								
Terra Corp.	R 10B			395	$395	$395	$395	$395	$495			
	TPX 10B	325	495	495	495	495	495	545	495	$375	$395	$370
	R 360			575	575	600	850					
	R 360 PORT			900	895	950	955	1,195				
	TX 720						795	895	895	895	945	945
Wulfsberg Electronic, Inc.	WT-200	2,195	2,095	2,095	2,328	2,495	2,900					
	WT-2000		2,995	2,995	3,328	3,529	4,167	4,417	4,682	4,682		
	WT-200B							3,627	3,627	3,627	3,863	4,515
Average		**1,587**	**1,584**	**1,504**	**1,491**	**1,589**	**1,644**	**1,947**	**2,174**	**2,342**	**2,397**	**2,682**
Average Annual Growth Rate			(.20%)	(2.67%)	(2.07%)	.03%	.70%	3.46%	4.59%	4.98%	4.68%	5.38%
Average Annual Growth Rate CPI			6.45%	7.05%	8.44%	9.69%	9.82%	9.20%	8.32%	7.81%	7.33%	6.73%
Total Growth Rate			(.20%)	(5.27%)	(6.09%)	.10%	3.57%	22.64%	36.92%	47.50%	50.97%	68.96%
Total Growth Rate CPI			6.45%	14.60%	27.51%	44.75%	59.77%	69.56%	75.01%	82.46%	88.97%	91.73%
Annual Change in Price			(.20%)	(5.07%)	(.87%)	6.59%	3.46%	18.42%	11.64%	7.73%	2.35%	11.92%
Annual Change in CPI			6.45%	7.66%	11.26%	13.52%	10.37%	6.13%	3.22%	4.26%	3.57%	1.46%

TABLE 1-4 (Cont'd)

AVIONICS EQUIPMENT PRICING 1976-1986
(In Dollars)

VHF Navigation Receivers

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Bendix Avionics Div.	RN-242A	$1,555										
Cessna Aircraft Co.	R-841	3,995										
	1048A NAV		$5,020	$4,495	$4,495	$4,195	$4,595	$5,650				
	R-1048B								$7,165	$7,165	$7,685	$8,0[illegible]1
Collins Radio	VIR-350		1,065	1,065	1,295	1,395	1,665					
	VIR-351	1,335	1,335	1,395	1,630	1,630	1,945	1,995	1,995	2,095	2,695	2,605
	SIRV-4		5,824	5,824								
Edo-Aire	R-552	595	595	595	675	715	715	715	715	715	750	750
	R-662	695	695	695	775	820	820	820	820	820	895	945
	R-554	1,155	1,155	1,155	1,295	1,373	1,373	1,373	1,373	1,373	1,425	1,425
	R-664	1,355	1,355	1,355	1,495	1,585	1,585	1,565	1,585	1,585	1,585	1,695
King Radio Corp.	KNR 632	3,445	2,595	2,920	3,465	3,465						
	KN 53			1,445	1,865	1,865	1,930	2,190	2,365	2,480	2,605	2,760
	KNR 630	4,545	3,395	3,620	4,200	4,200						
	KNR 615	5,260	3,450	3,600	4,465	4,465						
	KNS 81					4,050	4,815	5,460	5,990	6,195	6,505	6,185
	KNS 80					6,100	6,830	7,600	7,600	6,420	6,425	6,715
Mentor Radio Co.	M-200	675	675	675	675	745						
Narco Avionics	NAV 121		1,070	1,175	1,250	1,250	1,595	1.895	1,495	1,795		
	NAV 124		1,590	1,750	1,855	1,895	2,195					
	NAV 122		1,690	1,860	1,975	1,995	2,295	2,695	2,495	2,695		
	NAV 824						1,495	1,650	1,500	1,795	1,895	1,895
	NAV 825						1,695	1,995	1,850	2,195	2,395	2,395
Terra Corp.	R200	395	395	395	395	395	395	495				
	TN200							595	595	595	595	595
Average		**2,084**	**1,994**	**2,001**	**1,988**	**2,341**	**2,246**	**2,448**	**2,682**	**2,709**	**2,905**	**2,916**
Average Annual Growth Rate			(4.31%)	(2.00%)	(1.56%)	2.95%	1.51%	2.72%	3.67%	3.33%	3.76%	3.42%
Average Annual Growth Rate CPI			6.45%	7.05%	8.44%	9.69%	9.82%	9.20%	8.32%	7.81%	7.33%	6.73%
Total Growth Rate			(4.31%)	(3.97%)	(4.60%)	12.35%	7.81%	17.46%	28.69%	30.00%	39.39%	39.96%
Total Growth Rate CPI			6.45%	14.60%	27.51%	44.75%	59.77%	69.56%	75.01%	82.46%	88.97%	91.73%
Annual Change in Price			(4.31%)	.36%	(.66%)	17.77%	(4.04%)	8.95%	9.57%	1.01%	7.23%	.40%
Annual Change in CPI			6.45%	7.66%	11.26%	13.52%	10.37%	6.13%	3.22%	4.26%	3.57%	1.46%

TABLE 1-4 (Cont'd)

AVIONICS EQUIPMENT PRICING 1976-1986
(In Dollars)

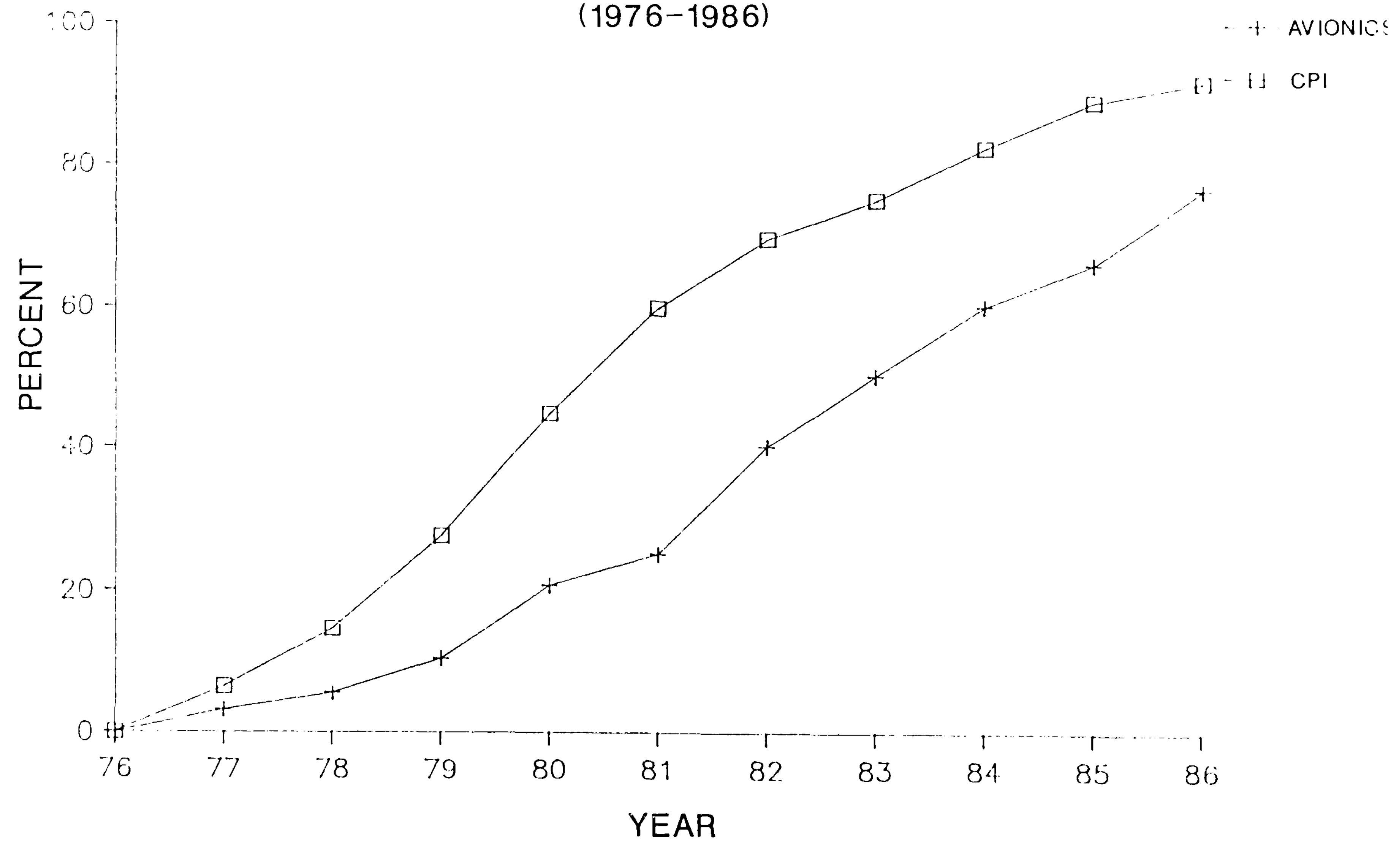
VHF Navigation Receiver/Communications Transceiver

Manufacturer	Model	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Bendix Avionics Division	CN-2013A		$2,928	$3,088		$3,376						
	CN-2012A		3,428	3,930	$3,840	4,311	$4,520	$5,085	$5,600	$7,170		
Cessna Aircraft Co.	RT-308C	$1,895	1,995									
	RT-328T	2,295	2,395									
	RT-428A	3,195	3,395									
	RT-385A			2,495	2,495	2,820	3,100	2,650	2,650	2,650	$2,740	$2,864
	RT-485A			4,195	4,195	4,390	4,660	3,600	3,600	3,600	3,690	[illegible]
Edo-Aire	RT-553	1,195	1,245	1,295	1,395	1,395						
	RT-553A	1,395	1,445	1,395	1,595	1,595	1,795	1,975	2,175	2,175	2,175	2,175
	RT-551/R-552	1,440	1,490									
	RT-661/R-662	1,640	1,690									
	RT-563	1,645	1,695	1,745	1,895	1,895						
	RT-563A	1,845	1,895	1,945	2,095	2,220	2,495	2,750	2,995	2,995	2,995	[illegible]
	RT-551A/R-544	2,100	2,150									
	RT-661A/R-664	2,400	2,450									
Genave	ALPHA/200B	800	800	995	1,100							
	GA-1000		1,395	1,395	1,395	1,600	1,600	1,560				
King Radio Corp.	KX 145	995	995	1,095	1,210	1,295	1,395					
	KX 170B	1,595	1,595	1,750	1,885	1,950	2,120	2,220				
	KX 175B	1,695	1,695	1,850	1,990	2,050	2,225	2,325	2,500	2,620	[illegible]	
	KX 155							3,000	3,000	2,540	2,670	[illegible]
	KX 165							3,560	3,850	3,850	4,045	[illegible]
Narco Avionics	ESCORT 110	875	925	1,020	1,240	1,240						
	COM 10A/NAV 10	1,510	1,690	1,915								
	MK-12D								1,995	2,495	2,595	2,595
Terra Corp.	R360/200/1			1,275	1,275	1,395	1,395	1,425				
	R300			2,850	2,995		1,995	1,995				
	NAV/COM								1,995	1,995		
Average		**1,677**	**1,865**	**2,014**	**2,040**	**2,252**	**2,482**	**2,679**	**3,036**	**3,209**	**2,958**	**3,116**
Average Annual Growth Rate			11.18%	9.57%	6.74%	7.65%	8.15%	8.11%	8.85%	8.45%	6.50%	[illegible]
Average Annual Growth Rate CPI			6.45%	7.05%	8.44%	9.69%	9.82%	9.20%	8.32%	7.81%	7.33%	[illegible]
Total Growth Rate			11.18%	20.05%	21.62%	34.28%	47.96%	59.70%	81.00%	91.31%	[illegible]	[illegible]
Total Growth Rate CPI			6.45%	14.60%	27.51%	44.75%	59.77%	69.56%	75.01%	82.46%	88.97%	91.73%
Annual Change in Price			11.18%	7.99%	1.31%	10.41%	10.19%	7.94%	13.34%	5.70%	(7.84%)	[illegible]
Annual Change in CPI			6.45%	7.66%	11.26%	13.52%	10.37%	6.13%	3.22%	4.26%	3.57%	1.46%

FIGURE 1-9

GROWTH RATE OF CPI AND AVIONICS AVERAGE PRICE

(1976-1986)



As the market begin to taper off, many fringe manufacturers ceased production enabling those in the business for the long term to increase their markup and improve profitability. At this time, the FAA is preparing rule-making to require a new-generation ELT which must meet tough standards for immunity against false activation. Meeting the new standards may cause another price increase. The FAA has also set December 1, 1987 as the date when all aircraft operating in Group I and II terminal control areas must be equipped with Mode C altitude reporting transponders, at an added cost of $600 to $900 per aircraft.

Over the period under review there has been very little change in FAA requirements for avionics. However, quality and capability of avionics have improved greatly over the last ten years because of technological advances. The advent of digital electronics has resulted in a substantial reduction in costs of production, size and weight and power required to operate. These improvements have also resulted in an increase in useful life of the equipment. In some cases, improved capability and smaller size have provided incentive for owners to purchase additional equipment for safety and convenience. This trend is expected to continue with elimination of wiring, remote installation and improved sensing making a better product. The most recent FAA General Aviation and Avionics Survey indicates that 83 percent of the aviation fleet is becoming more sophisticated in terms of its avionics equipment. There was a significant shift from 360 channel to 720 channel two-way communications equipment. There was also a substantial increase in the number of GA aircraft containing 4096 code and altitude encoding transponders. It appears that there will be no rapid increases in avionics costs in the near future. However, a continuing decline in the production of small aircraft reducing the market for certain avionics could increase marginal costs.

INSURANCE COSTS

Costs for aircraft hull insurance have been practically constant as a percentage of hull costs over the last several years, according to insurance industry representatives. They have remained at the 5 percent level. Actual costs have risen due to the rapid rise in aircraft prices. Liability costs were declining until about three years ago, when they suddenly skyrocketed. Costs for $1,000,000 in liability coverage, which were $90 three years ago, are now $965. Most pilots have compensated by changing liability limits and deductables, so that a typical liability premium is now about $350. Similiar liability cost increases have hit the Fixed Base Operators.

OPERATING COSTS--MAINTENANCE AND FUEL

Operating costs are an important factor in the purchase decision for small aircraft. Costs per flight hour for maintenance and overhaul and fuel over a sixteen year period are displayed in Table 1-5. It can seen that with a few exceptions, 1973, 1976 and 1982, maintenance costs increased at a gradual pace, frequently less than the rate of inflation. The overall average annual increase was 7.75 percent and for the past ten years, 5.36 percent.

TABLE 1-5

SINGLE ENGINE PISTON AIRCRAFT - OPERATING AND MAINTENANCE COSTS

1970-1986

Year	Hourly Maintenance and Overhaul Costs	Fuel Costs per Gallon	Hourly Fuel Costs	Hourly Total Costs	Hourly Total Cost Index (1972=100)	Consumer Price Index
1970	$1.40	$.434	$4.35	$5.75	95.0	92.8
1971	1.51	.432	4.33	5.84	96.5	96.8
1972	1.62	.442	4.43	6.05	100.0	100.0
1973	1.97	.486	4.87	6.84	113.1	106.2
1974	2.10	.657	6.59	8.69	143.6	117.9
1975	2.25	.702	7.04	9.29	153.5	128.7
1976	2.74	.765	7.67	10.41	172.0	136.1
1977	2.99	.893	8.96	11.95	197.4	144.9
1978	3.11	1.020	10.23	13.34	220.4	155.9
1979	3.26	1.220	12.24	15.50	256.0	173.5
1980	3.48	1.610	16.15	19.63	324.3	197.0
1981	3.68	1.880	18.86	22.54	372.3	217.4
1982	4.10	1.960	19.66	23.76	392.5	230.7
1983	4.36	1.990	19.96	24.32	401.8	238.1
1984	4.53	1.970	19.76	24.29	401.3	248.3
1985	4.57	1.930	19.36	23.93	395.3	257.1
1986	4.62	1.820	18.25	22.87	377.9	260.9

Source: Federal Aviation Administration

Cost of aviation gas on the other hand, increased dramatically over the same period. The most extreme jump occurred in 1973 to 1974. This can be attributed to nationwide energy shortages at that time which pushed prices up rapidly. Although the growth rate slowed for the next two years, the 1974 cost set a higher base to be compounded in the future. The years 1977 through 1981 saw very large year over year increases. The average annual sixteen year growth rate was 9.37 percent while the rate over the past ten years was 9.05 percent. This number is mitigated by the fact that for the last three years there has actually been a small decrease. The final column shows that the operating cost per flight hour has more than doubled from $10.41 in 1976 to $22.87 in 1986. Table 1-6 and Figure 1-10 also indicate that with 1972 as base year, growth rate in operating costs has increased at a substantially higher rate than the CPI, exceeding it in every year. The peak year was 1983 but there is still a wide discrepancy in 1986.

However, operating cost has stabilized and even decreased slightly in the last two years. Fuel cost is not thought to be a major deterrent to flying at this time. Aircraft operators have become desensitized to aviation gas price since the first shocking jumps in 1974 and again in 1979 and 1980 just as automobile operators accept $1.00 gas as a given. Other factors have moved to the forefront in making the decision to buy/fly.

GENERAL AVIATION HOURS FLOWN

Hours flown in general aviation activities as shown in Table 1-7 exhibited steady growth reaching 41.6 million in 1980 when

TABLE 1-6

MAINTENANCE AND OPERATING COST GROWTH RATES

1970-1986

Year	Hourly Maintenance and Overhaul Costs	Annual Change	Ten Year Average Change	Fuel Costs per Gallon	Annual Change	Ten Year Average Change
1970	$1.40			$.43		
1971	1.51	7.86%		.43	-.46%	
1972	1.62	7.28		.44	2.31	
1973	1.97	21.60		.49	9.95	
1974	2.10	6.60		.66	35.19	
1975	2.25	7.14		.70	6.85	
1976	2.74	21.78		.77	8.97	
1977	2.99	9.12		.89	16.73	
1978	3.11	4.01		1.02	14.22	
1979	3.26	4.82		1.22	19.61	
1980	3.48	6.75	9.53%	1.61	31.97	14.01%
1981	3.68	5.75	9.32	1.88	16.77	15.84
1982	4.10	11.41	9.73	1.96	4.26	16.06
1983	4.36	6.34	8.27	1.99	1.53	15.14
1984	4.53	3.90	7.99	1.97	-1.01	11.61
1985	4.57	.88	7.34	1.93	-2.03	10.64
1986	4.62	1.09	5.36	1.82	-5.70	9.05

FIGURE 1-10

HOURLY OPERATING COSTS AND CPI

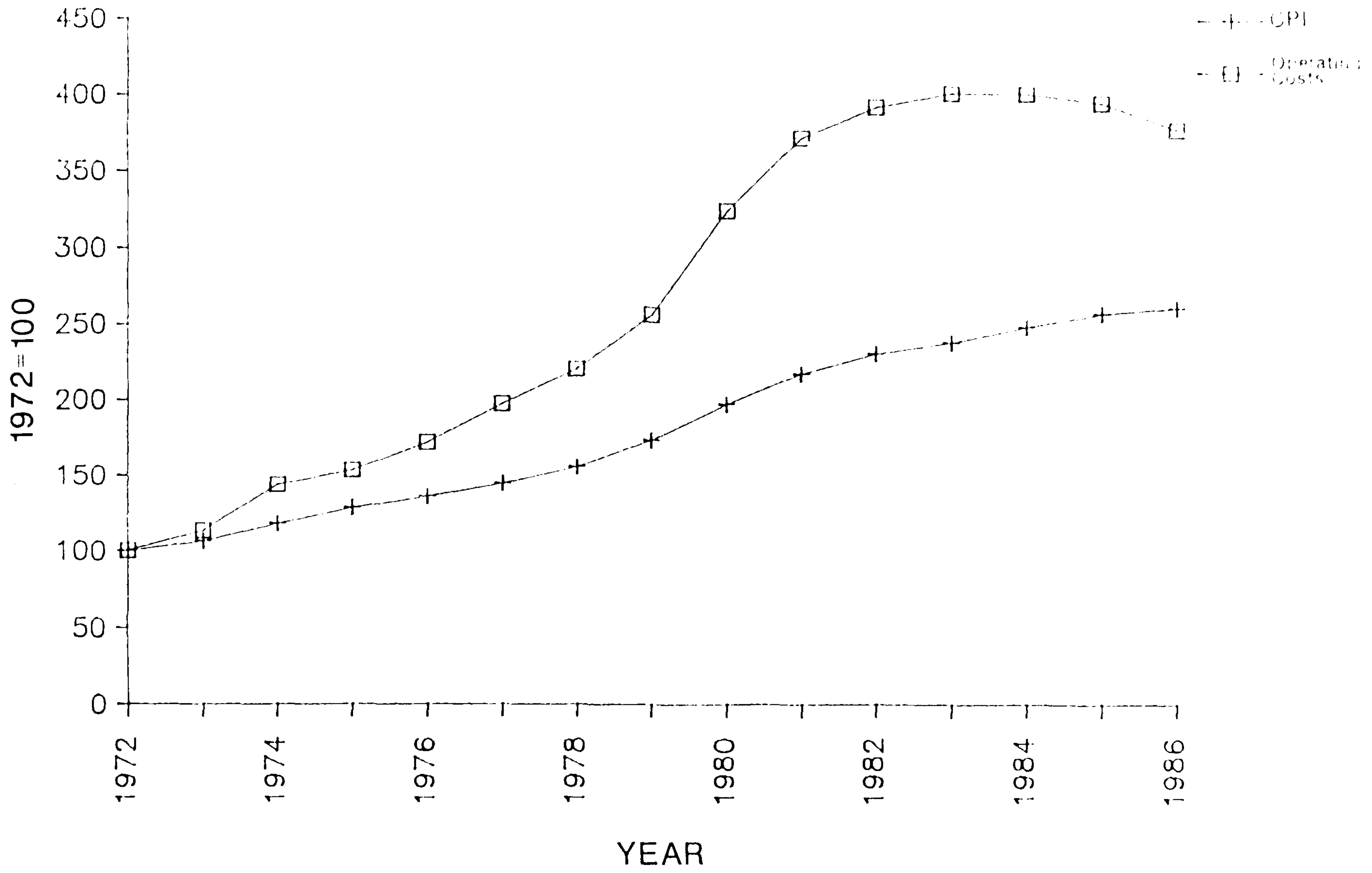


TABLE 1-7

GENERAL AVIATION HOURS FLOWN

1972-1985

Year	General Aviation Hours Flown (000,000)
1972	26.4
1973	28.5
1974	30.7
1975	31.7
1976	33.0
1977	35.3
1978	37.1
1979	39.0
1980	41.6
1981	41.1
1982	37.8
1983	36.4
1984	35.9
1985	36.6

the trend suddenly reversed, and in 1981 the hours dropped to 41.1 million. That particular drop was partially attributed to the controllers strike, but the downtrend continued until a small upward shift to 36.2 in 1985. In 1986, the downtrend resumed to 33.8 million. The change was actually 20 percent over the six year period from 1980 to 1985, not nearly as striking as the decrease in new aircraft shipments. Hours flown by SEP went from 28.8 million in 1980 to 22.4 million in 1986, a 22 percent decrease.

FLIGHT SCHOOLS AND STUDENT PILOTS

The number of flight schools and student pilots have dropped steadily since the late 1970's. The figures below show the number of schools has decreased from 2,706 to 876 since 1976. The drop in flight schools not only indicates that there are fewer students learning to fly but that the schools are buying fewer small training aircraft.

Year	Number of Flight Schools
1976	2706
1977	1656
1978	1634
1979	n/a
1980	1568
1985	1100
1986	876

The number of student pilots is shown in Table 1-8. Figure 1-11 shows the decline in the major age groups. The number of student pilots dropped steadily until 1986 when there was a marked upturn. Meanwhile, the average age of student pilots has increased. These changes may be attributed to a number of

TABLE 1-8

STUDENT PILOT STARTS

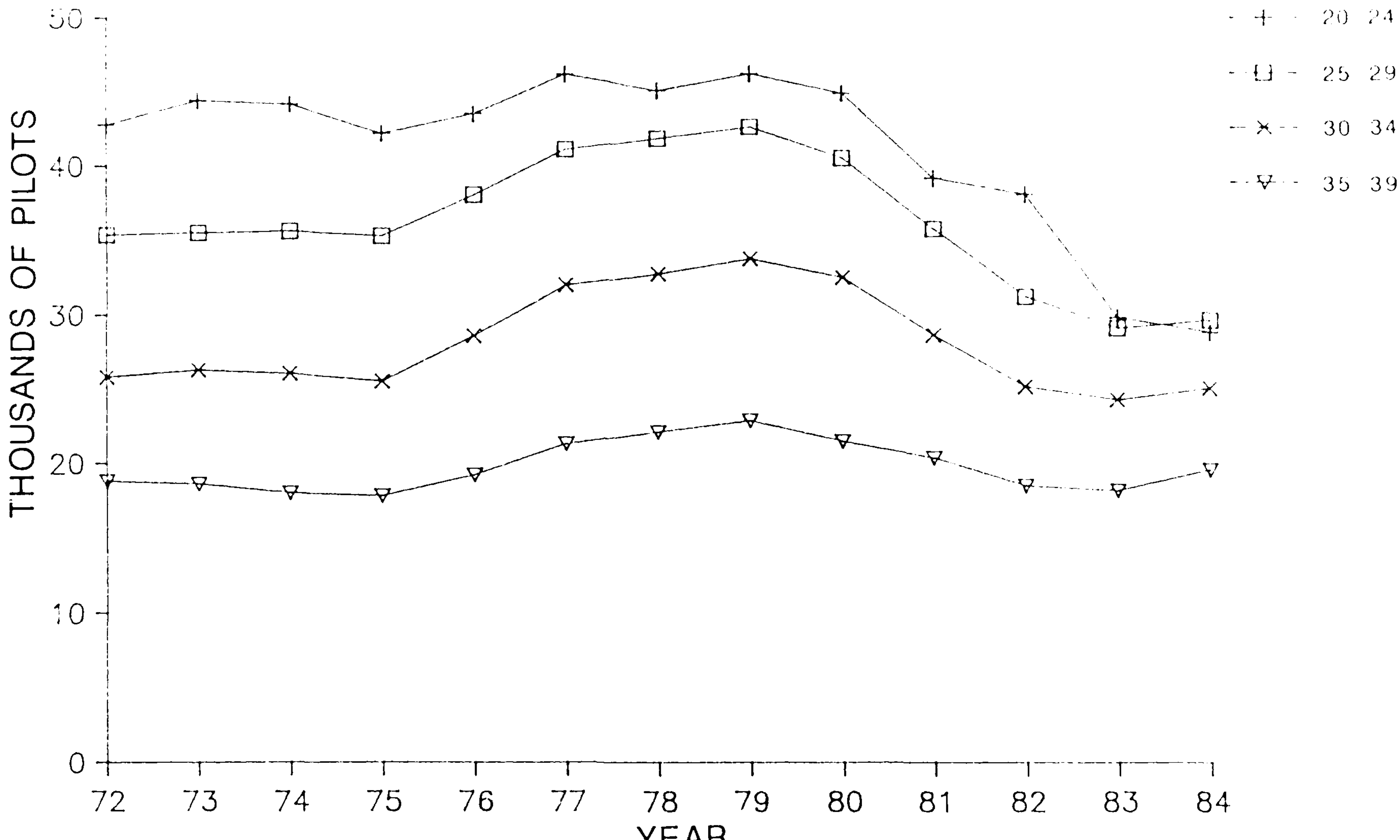
1972-1986

Year	Student Pilot Starts
1972	121,543
1973	131,384
1974	113,997
1975	127,424
1976	129,280
1977	138,816
1978	137,032
1979	139,956
1980	102,301
1981	117,962
1982	84,761
1983	94,981
1984	91,395
1985	80,060
1986	88,706

Source: Federal Aviation Administration

FIGURE 1-11

STUDENT PILOTS BY AGE GROUP



SOURCE · FAA STATISTICAL HANDBOOK OF AVIATION factors: cost of training, which has risen from about $1,500 in 1978 to about $3,000 today, an increase in the number of activities available to young people, and high college tuition costs, which soak up available funds.

ACTIVE PILOTS

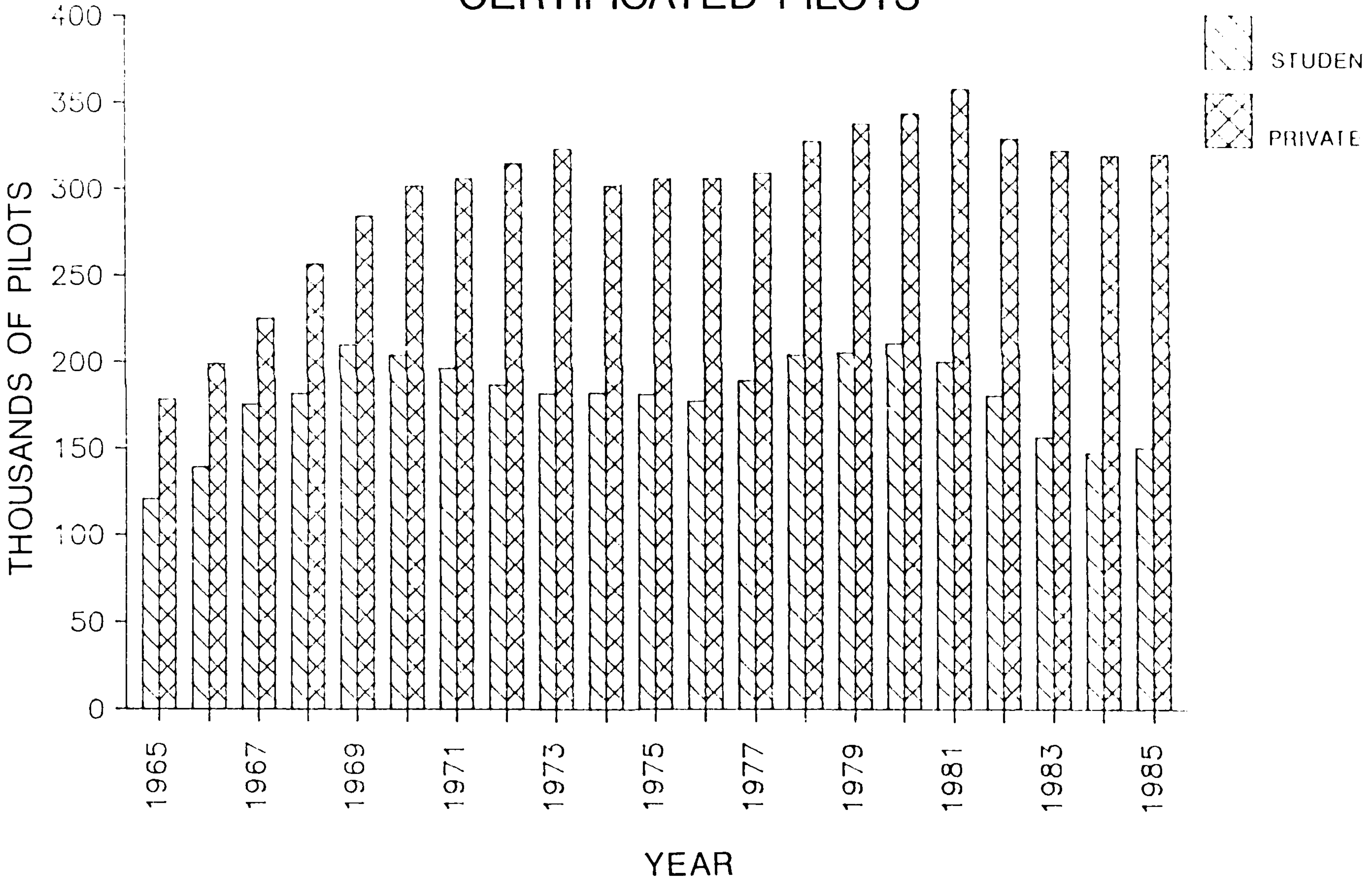
Figure 1-12 indicates the recent decline in both student and private pilots. These data were examined by age, particularly for the 20-39 age groups where most flying activity occurs, especially new starts. As Table 1-9 and Figures 1-13 through 1-17 indicate, pilot participation rate has declined over the last fifteen years for both students and all pilots. Even though the general population has been growing in all of the flying age groups, the number of pilots has declined slightly, which means that the number of pilots per capita has declined significantly. This is especially pronounced in the younger age groups where the increased costs of flying have met with the most resistance. A lack of promotion of flying has also contributed to the decline. Less than half the percentage of the population is learning to fly today as did in 1970, and the drop in active pilots is 33 percent. As the number of students continues to decline, and active pilots age and drop out of the market, that participation rate will continue to decline. Recent increases in students, who seem primarily interested in an aviation career, may help reverse the trend.

STRUCTURAL CHANGES IN THE MARKET

What appears to have happened, based on the historic data, is a major change in the structure of the single engine piston

FIGURE 1-12

CERTIFICATED PILOTS



SOURCE: FAA STATISTICAL HANDBOOK OF AVIATION

TABLE 1-9

PERCENT OF FLYING AGE PUBLIC HOLDING PILOT CERTIFICATES

Year	Percent of Student Pilots	Percent of Private Pilots
1970	.84	1.25
1971	.78	1.21
1972	.7[illegible]	1.19
1973	.66	1.18
1974	.64	1.06
1975	.61	1.03
1976	.58	1.00
1977	.59	.97
1978	.62	1.00
1979	.60	1.00
1980	.60	.98
1981	.55	.99
1982	.49	.89
1983	.41	.86
1984	.38	.83
1985	.39	.82

Note: Flying age public defined as males 20-39.

FIGURE 1-13

PILOTS PERCENTAGE OF MALE POPULATION

(BY AGE GROUP)

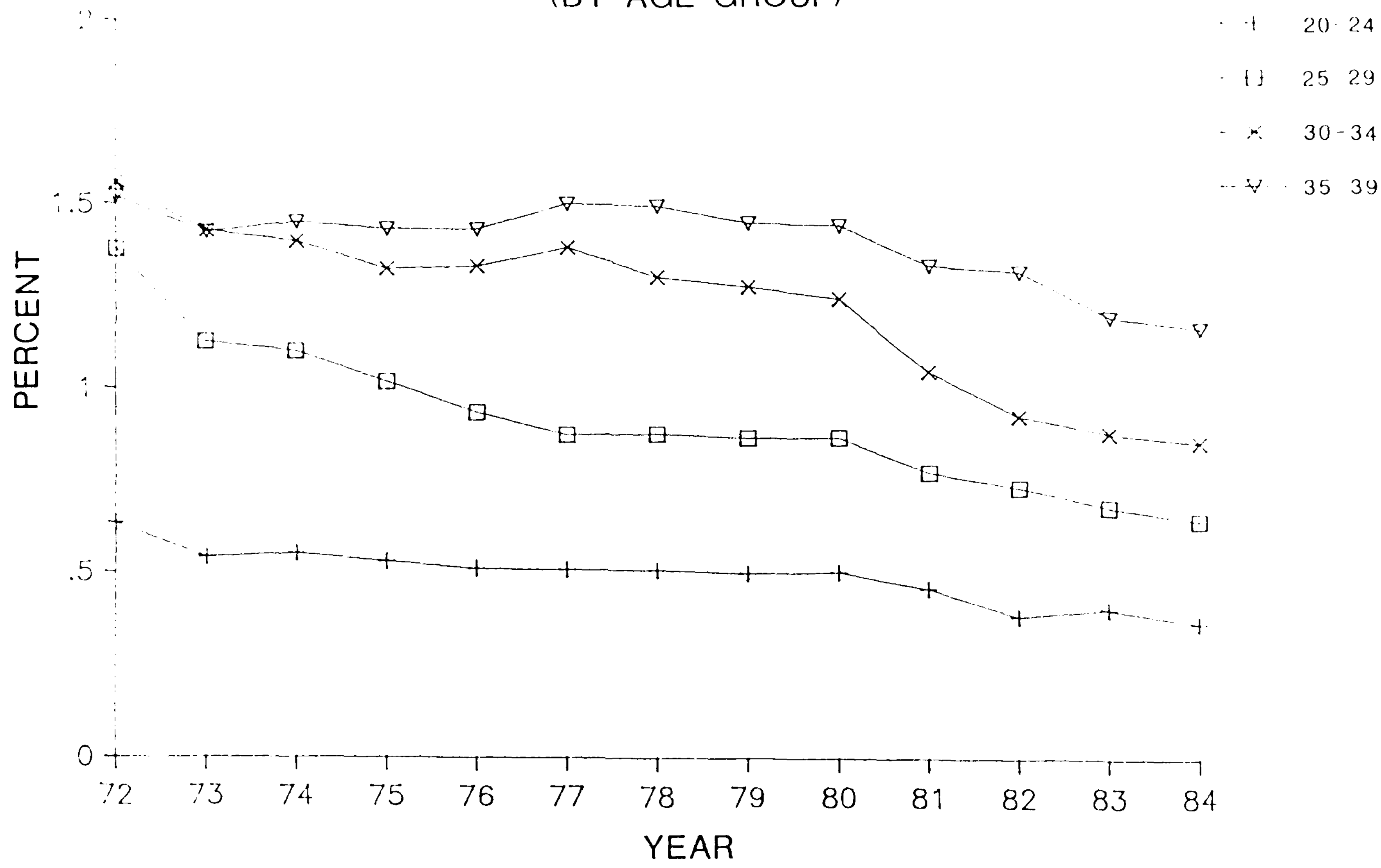


FIGURE 1-14

GROWTH RATE OF STUDENT, PRIVATE PILOTS AND POPULATION-AGE 20-24

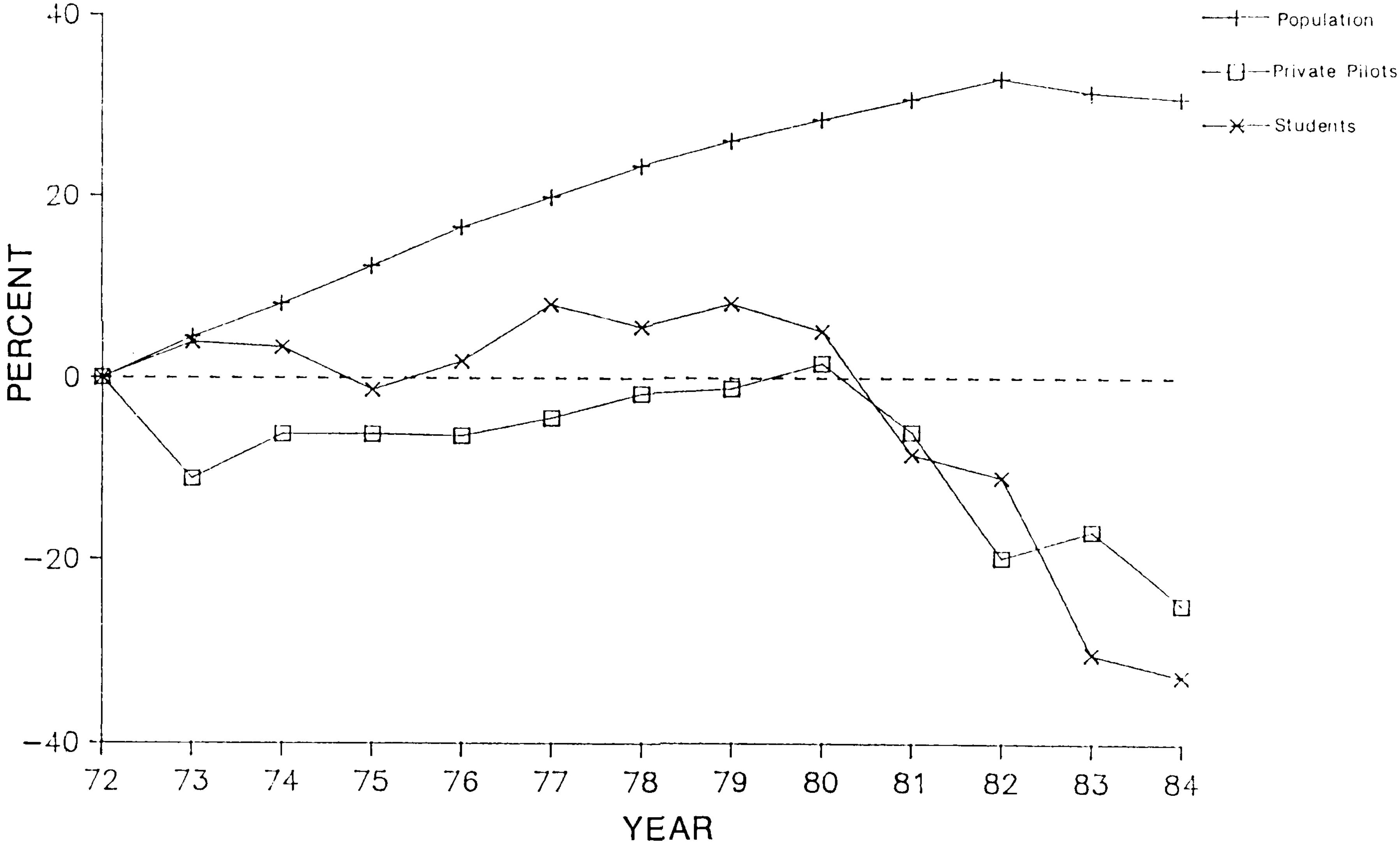


FIGURE 1-15

GROWTH RATE OF STUDENT, PRIVATE PILOTS AND POPULATION - AGE 25-29

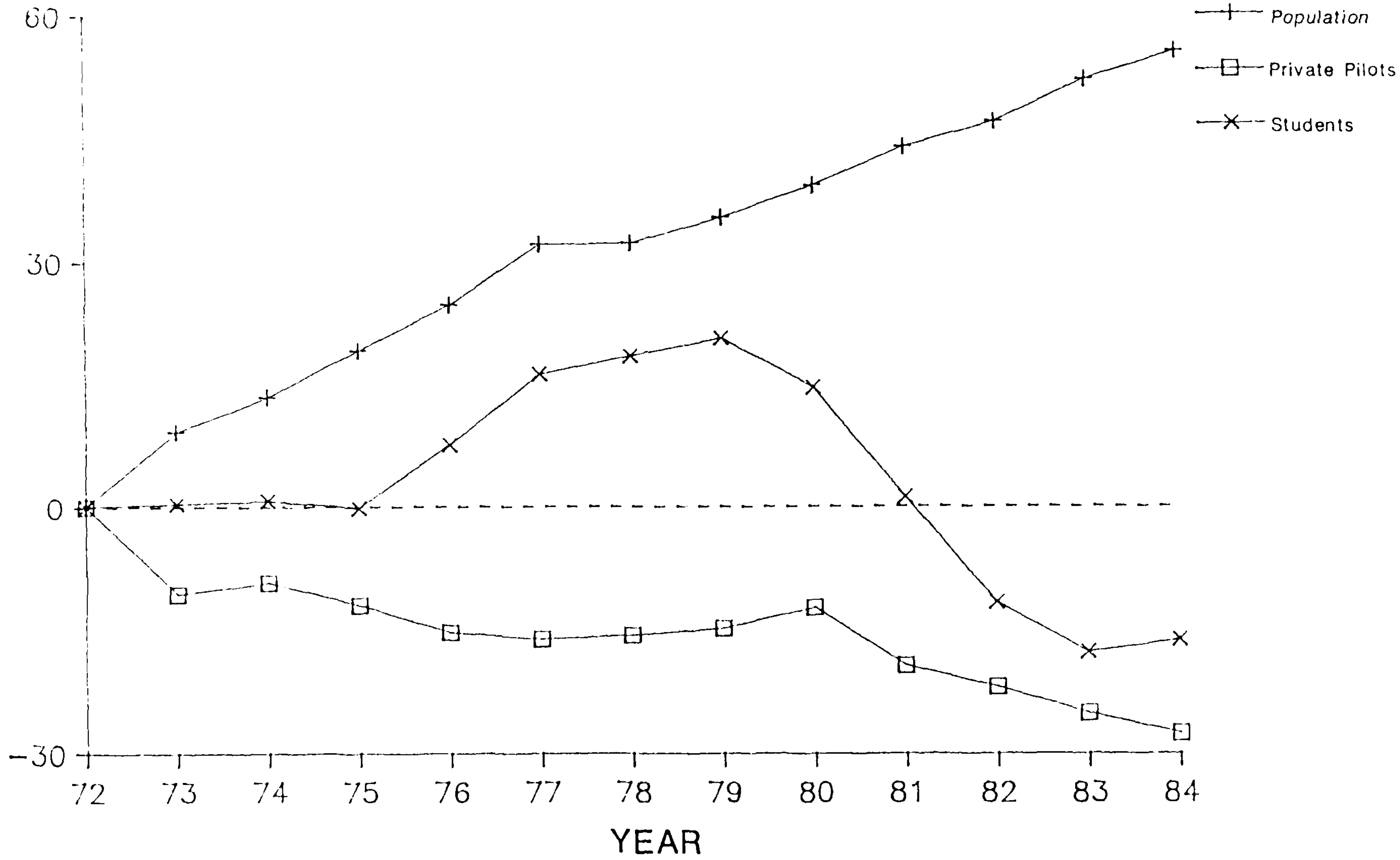


FIGURE 1-16

GROWTH RATE OF STUDENT, PRIVATE PILOTS AND POPULATION - AGES 30-34

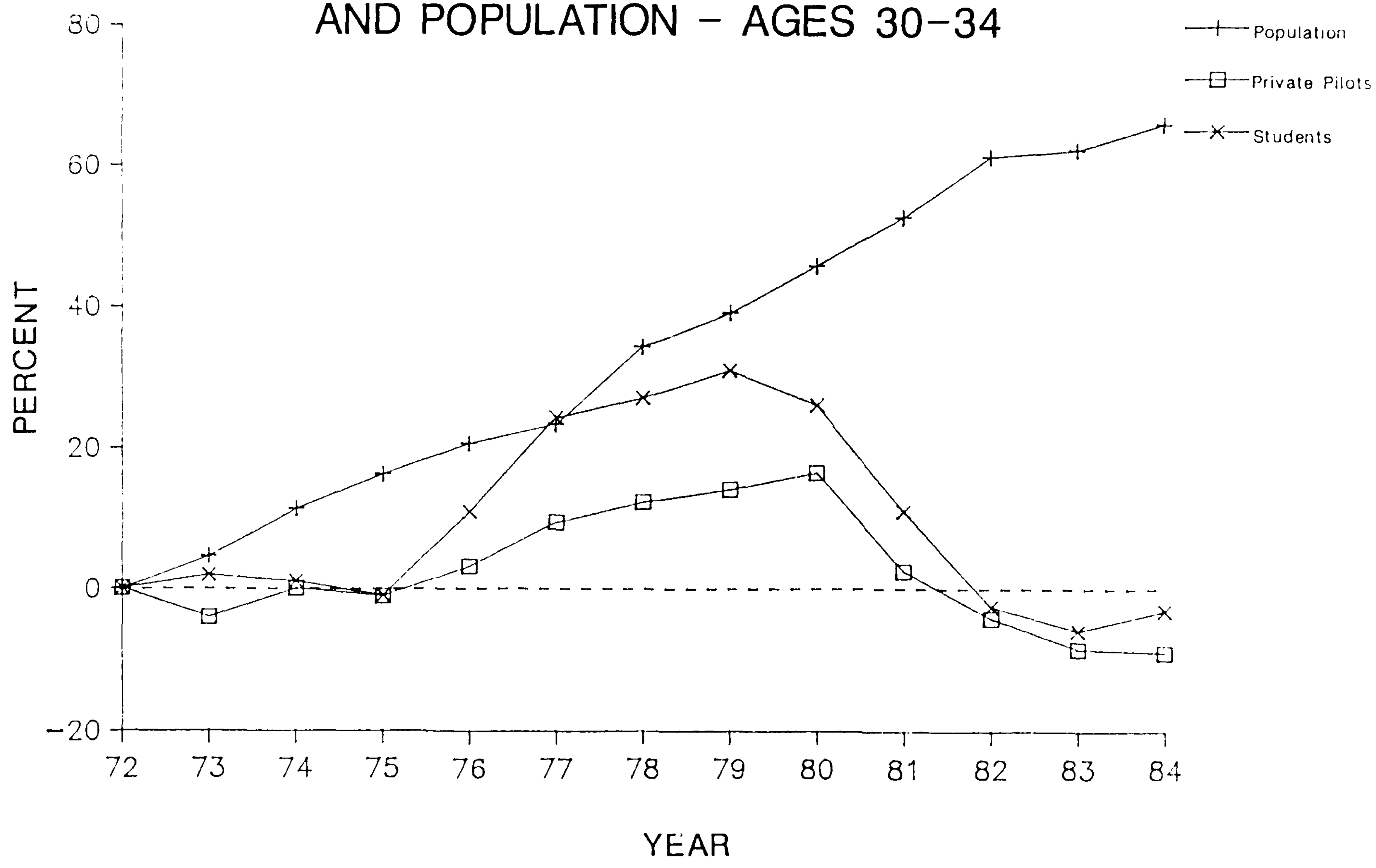
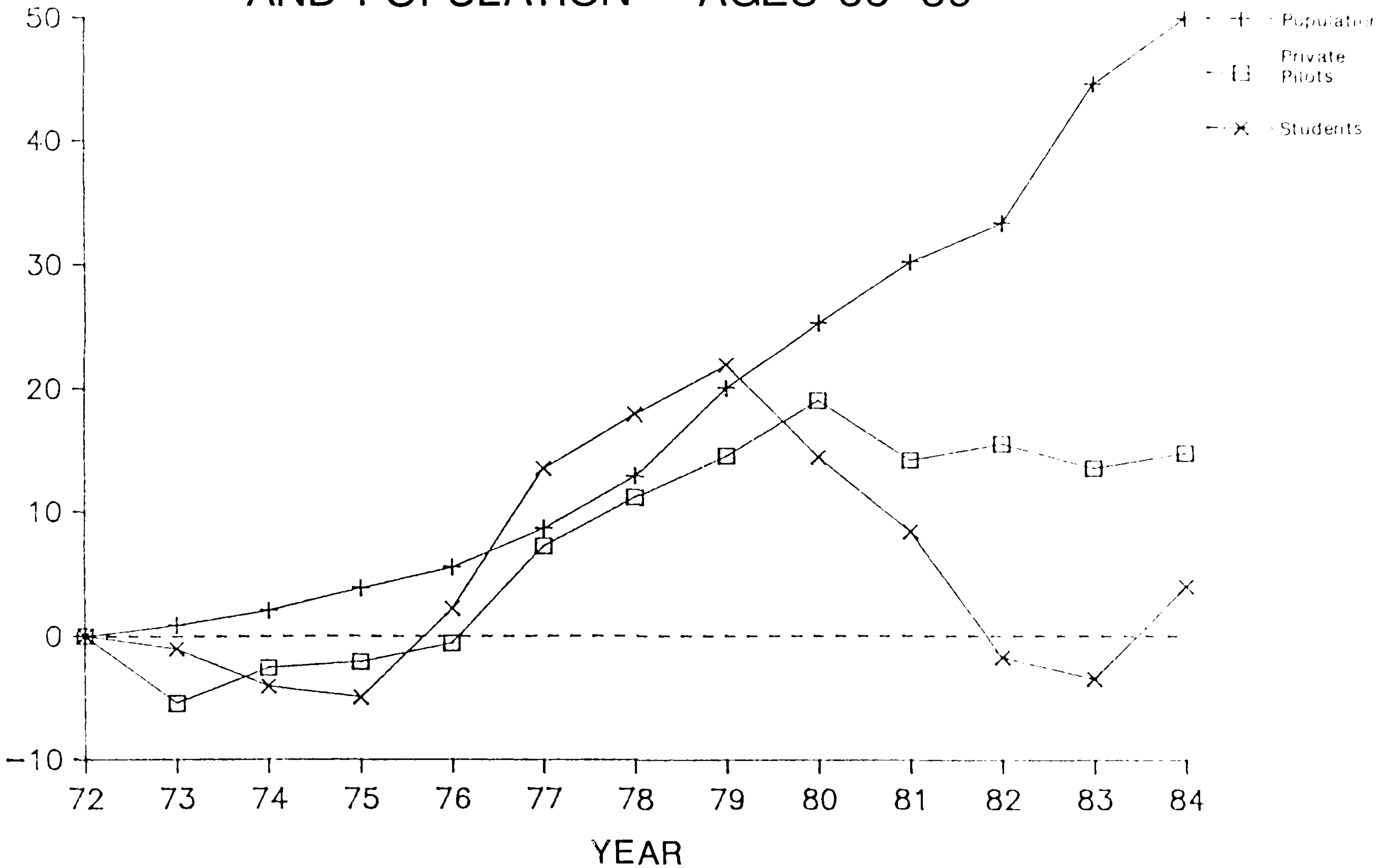


FIGURE 1-17

GROWTH RATE OF STUDENT, PRIVATE PILOTS AND POPULATION - AGES 35-39



market. There is less interest in flying as a recreational activity, and less interest in learning to fly. The decline should be viewed from the mid-seventies, not from the peak years of 1979-1981. Those years represented an anomaly, increased activity and increased sales due to double digit inflation and a one-time external factor, the expiration of the GI Bill benefits. Interest in flying has declined for several apparent reasons:

- increased real costs of flying;
- increased shares of disposable income spent on for housing, transportation, etc.;
- an end to the glamour of recreational flying;
- an increase in the emphasis on family oriented recreational activity;
- a hassle factor related to the complexity of urban flying;
- the availability of inexpensive commercial flights;
- the increase in regional airline service at small airports; and
- a change in the attitude of veteran military pilots toward flying as an avocation.

ECONOMETRIC MODELING

A database of information was assembled for use in econometric modeling. The contents of that database, complete for 1972-1985, includes:

- Year
- Single Engine Piston Shipments from manufacturers, with and without agricultural aircraft
- The value of single engine piston shipments in current dollars
- The unit value of single engine piston shipments in current dollars
- Multi-engine piston shipments form manufacturers

- Turbo-prop engine shipments from manufacturers
- Jet engine shipments from manufacturers
- Total units shipped
- Total billings in current dollars
- Average price for all aircraft shipped in current dollars
- Number of student pilots
- Number of general aviation hours flown
- Itinerant general aviation aircraft operations
- Local general aviation aircraft operations
- Total general aviation aircraft operations
- Housing cost index
- Insurance cost index
- Annual disposable income in current dollars
- Annual per capita income in dollars
- Average annual aviation gasoline price in current dollars
- Gross National Product in current dollars
- Gross National Product deflator
- Consumer Price Index
- Average annual Treasury Bill interest rate
- Average annual Prime interest rate
- Personal consumption expenditures
- Maintenance and overhaul costs for general aviation
- Hourly fuel costs for general aviation
- Total operating costs for general aviation
- Flight plans filed at Flight Service Stations
- Pilot briefings at Flight Service Stations
- Aircraft contacts at Flight Service Stations

These data were entered into a data base using SPSS, a statistical analysis package, and the statistics below were all derived from that database.

A study done at Stanford Research Institute and presented at the Transportation Research Board Annual Meeting[2] put forth the hypothesis that helicopter and turbo-prop aircraft sales were related to real costs, real GNP, and inflation, and explained the slump in sales as resulting from a "surplus" of aircraft acquired during the period of high inflation because they were purchased

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[2]Hollyer, Mark R. and Starry, Claire, **A New Modeling Approach for Small Commercial Aircraft Sales**, Paper presented at the January 1987 Transportation Research Board Annual Conference, Stanford Research Institute, Menlo Park, CA.

as investments. This resulted in a change in the structure of the market, which did not represent a long term trend. With the decline in inflation, this investment stopped. The surplus was then available again for direct use, dampening the sales of newly manufactured aircraft. Statistical testing of the hypothesis indicated validity.

This study attempted to duplicate these results for the single engine piston market, even though the market has always been structured differently, with many aircraft purchased wholly or in part for recreational use. The results, as expected, were not encouraging, with correlation coefficients below 0.70. This led to the conclusion that the SRI hypothesis does not fully explain the changes in single engine piston sales, and that other factors were influencing market behavior.

Using SPSS, a variety of statistical analyses were performed. Correlation coefficients were examined for all variables with single engine piston sales as the dependent variable. Chronological plots were developed for all variables for analysis, and the logical promising variables tested in combination using linear regression analysis. Stepwise regression was used to pick out the combinations that looked most promising.

The best results were obtained using two variables, which individually did not have a high correlation, but taken together they seemed to explain the entire curve. These two variables were actual aviation gasoline price (which is in fact a surrogate for operating costs and inflation) and annual hours flown. The equation the resulted from the stepwise linear regression analysis is:

```
SEP = 965.62*HOURS - 156.98*AVGAS - 13795.77
       (12.76)        (-20.15)        (-6.16)

R̄**2 = 0.97;  D-W = 1.46;  Observations = 14;
t-Statistics in parenthesis
```

Where:

```
  SEP = Single Engine Piston Aircraft Shipments
HOURS = General Aviation Hours Flown
AVGAS = Retail price of Aviation Gasoline in current dollars
```

Predicted and actual single engine piston shipments are shown on Figure 1-18.

Other promising variables included Student Pilots and Maintenance and overhaul costs. None of the national economic variables tested was effective in explaining the continuing decline in single engine piston shipments. The database and correlation matrix are in Appendix D.

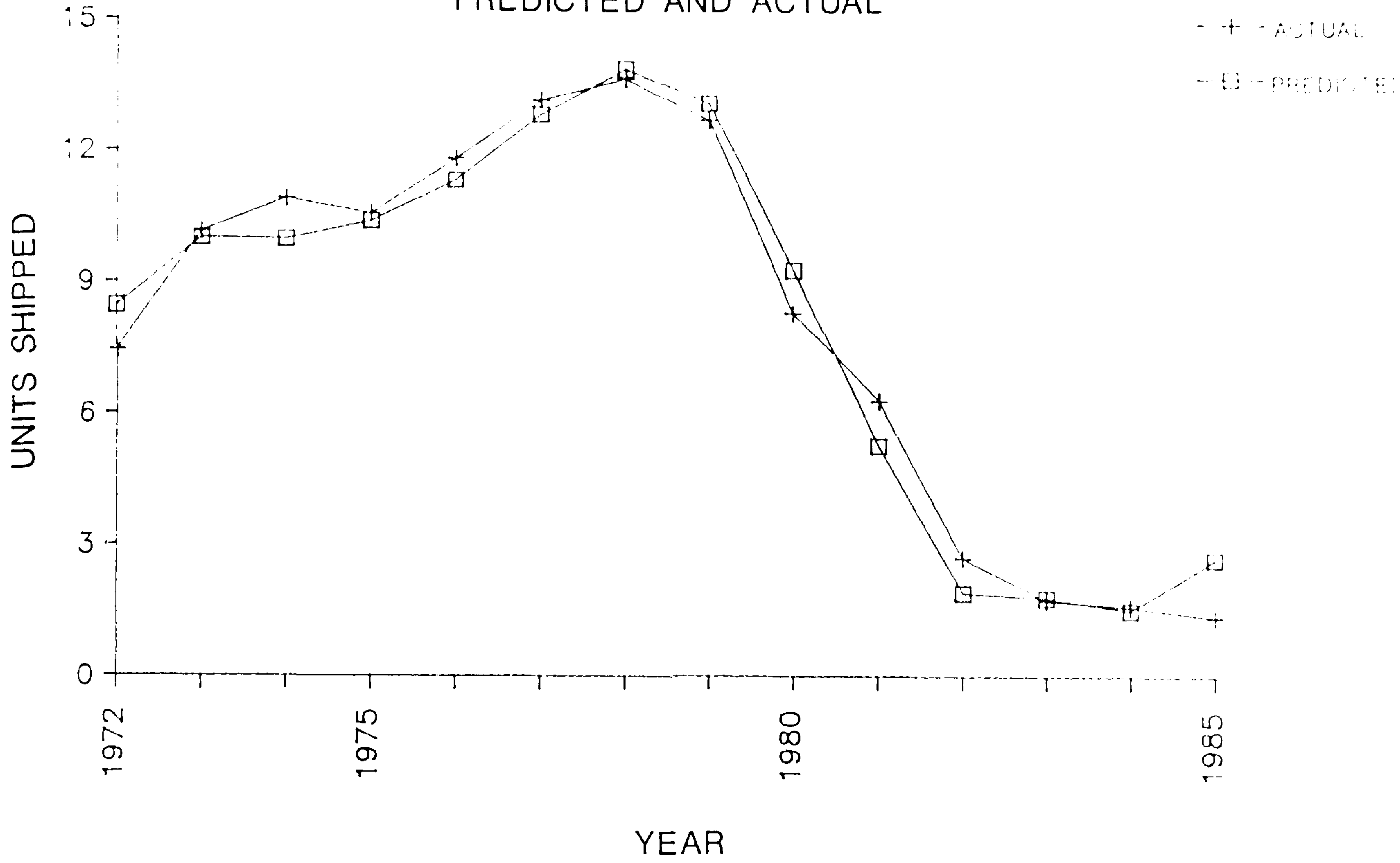
COMSIS' interpretation of these data is that the decline in single engine piston sales has been caused by two related phenomenon: the increasing costs, especially operating costs, of flying; and a declining interest in flying on the part of the public, as evidenced by the decline in the percentage of students and licensed pilots in all the flying age groups discussed above. Each of these factors has a number of elements contributing to it.

The increasing costs are a result of inflation, insurance cost increases, fuel cost increases, and higher prices that resulted from widening markups and a multitude of factors affecting aircraft production costs. With decreasing oil prices

FIGURE 1-18

SINGLE ENGINE PISTON SHIPMENTS

PREDICTED AND ACTUAL



and declining inflation, these costs may be mitigated, but the real cost of flying an airplane is still out of the range of most of the potential market. The degree to which the price of a new airplane has affected this perceived cost of flying is not as great as expected. THe correlation between current price of aircraft and units shipped was only 0.72. When the price was adjusted for inflation, the correlation was even less at 0.69. Lagging "units shipped" one year produced no better relationship. This may be partially due to the large stock of relatively new aircraft available.

The used aircraft market has remained strong and active throughout the decline. Last year an estimated 60-80,000 used general aviation aircraft changed hands, and the price for these aircraft remains strong. There is a significant savings in the cost of a "hardly used" low time aircraft over the cost of the equivalent new aircraft, and the lack of model changes and technological improvements has enhanced that savings. The aircraft manufacturers have acknowledged that their production peak occurred after the demand had peaked, and that they built a large backlog of aircraft while winding down production lines. Many of these aircraft were pushed into the pipeline, where they sat unused or hardly used as inventory of the Fixed Base Operators. Today, a large supply of low-hour 1979 to 1981 aircraft are still available for purchase. Until these are "used up" or became obsolete, they will remain the major deterrent to renewed sales of single engine piston aircraft. The rate at which they are being consumed is declining as a result of a declining interest in general aviation flying on the part of potential and current pilots. Part of this decline is clearly related to costs, but several interviewees commented on other factors which also have an impact. Some of the glamour is gone from small aircraft flying. "There are no longer kids hanging around the airport offering to wash your plane for a ride." Returning veterans, unaided by the GI Bill, are no longer enamored with the possibility of weekend flying. The only real boost to pilot training today is the shortage of commercial pilots. The complexity of the air space in urban areas, where most potential flyers now live, has discouraged pilots, who fear the delays and the complicated requirements of flying in or around Terminal Control Areas. This declining rate of participation in general aviation activity is probably a long term phenomenon that should be reflected in any forecasts of aircraft sales, as well as activity measures.

CHAPTER TWO

CURRENT STATUS OF THE GENERAL AVIATION INDUSTRY

MANUFACTURERS

Shipments of general aviation aircraft in 1986 continued their downward trend despite a brief flurry at the end of the year spurred by tax law changes. Over the past two years, the structure of the industry has changed. All major manufacturers are now owned by larger companies.

Aircraft

Manufacturer	Owner
Beech	Raytheon
Cessna	General Dynamics
Piper	Lear Sigler
Mooney	Eurailair (French)

Engines

Manufacturer	Owner
Avco Lycoming	Textron
Continental	Teledyne

At this time, Cessna has ceased manufacturing single engine piston aircraft, and Beech is producing only the Bonanza. The price has been reduced from the 1986 price of $164,000 to $131,750 in an effort to spur sales. Beech's research indicates the the market segments for the aircraft are:

- 14% manufacturing
- 24% wholesale and retail trade
- 15% finance, insurance and real estate
- 11% medical
- 10% contract construction and
- 26% other.

This implies that at least 74 percent of the purchases of this price aircraft are for business purposes. It is anticipated 1987 sales will reach about 100. The two engine Baron will account for about another 100. Production at that level will not be profitable but will contribute to overhead. Beech never redesigned the piston production lines to maximize efficiency at high volumes, as Cessna and Piper did, so they can build as the market demands. A Beech survey finds that the mean age of the first time aircraft purchaser is now 35 and price weighs heavily in the purchase decision.

Piper has suspended production on all models except the Malibu, with no date set for resumption. Piper's workforce of 1,000 will be reduced by "several hundred" over the next few months. Piper faces an uncertain future since its parent company, Lear Sigler has recently been purchased by L Aquisitions, a corporation organized by Forstmann Little for the takeover of Lear Sigler.

Among the small manufacturers, Ballanca, which first began manufacturing aircraft in 1936, has been reorganized under Chapter 11, and with current staffing could produce one airplane a month. Ballanca continues to refurbish their aircraft and supply parts. Taylorcraft recently sought protection from creditors under Chapter 11 while it attempts to reorganize. It produced sixteen aircraft in 1986 and will continue to produce parts for the 2,800 airplanes currently operating. Mooney Aircraft Corporation is producing the new Mooney 201, "Lean Machine" for $98,000 and the 205SE which will be certificated in

June. Mooney has also applied for certification of a 201 using the new Porsche 220 hp PFM 3200-3 air-cooled piston engine. Maule and Lake also continue production, with Maule aircraft priced in the $50,000 range. The aftermarket for parts, spares, and refurbishment of aircraft is now an important part of all manufacturers' business.

PRODUCT LIABILITY AND INSURANCE

Product liability costs for manufacturers have skyrocketed in the last three years. Huge awards or settlements have driven up costs. Claimants have sued all possible defendants regardless of the extent of their liability and the claims often end up at the doorstep of the "deep pockets" manufacturer rather than with some small FBO maintenance facility or the pilot himself. At the same time, some manufacturers were reluctant to make settlements, resisting all claims and forcing them into court. In 1985, the manufacturers and their insurers paid $209.6 million in judgements, settlements, and defense costs, compared to $46.6 million in 1981 and $76.8 million in 1983. The manufacturers report in 1985 insurance costs averaged $70,000 for each airplane delivered. This figure is spread over a base of less than 2,000 delivered units. This amount, if added to the price of small aircraft, would make the price astronomical. In practice, it is actually spread over all models, from $6 million jets to $80,000 single engine pistons.

Fewer than a dozen major underwriters of aircraft product liability currently exist, most of whom are in London. These foreign insurers do not relate to U.S. product liability laws and consider U.S. manufacturers poor risks while they must operate in such a legal framework. As a consequence, they require that the companies must be self-insured for as much as one-third or more of their potential liability and pay extremely high premiums for the balance.

A general aviation product liability bill was introduced in both houses of Congress in the last session and virtually the same bill was introduced this session. The purpose of the bill is to provide nationwide uniform standards of liability for harm arising out of general aviation accidents. Many states have product liability laws with widely varying provisions. The nature of aviation is such that a claimant can virtually choose the state in which to institute legal action. The bill's primary thrust is to limit the number of years a manufacturer can be held liable (currently it is unlimited, covering 30 to 40 year old airplanes) and to apply the principle of comparative responsibility which would make the defendant responsible only for the percentage of damage attributable to him. Those who follow this legislation closely believe chances are poor that Congress will consider the bill this 100th session.

USED AIRCRAFT MARKET

Used aircraft offer a viable alternative to new. There is currently a good supply with many low-time aircraft bought during the buying surge of the late '70's still available. The Aviation Finance Association (bankers for the aviation community) estimates that 117,000 aircraft went into service in the 1977-79 period and that probably half the used aircraft have less than 1,000 hours.

The market is active with average six year old aircraft available at prices ranging from $22,500 to $40,000. Table 2-1 shows new and used prices of selected models for comparison. New aircraft offer very few enhancements in styling and technical capability and the price spread of $15,000 to $50,000 between new and used aircraft shows clearly that there is strong incentive to buy used aircraft. The Aviation Finance Association estimates that 60,000 to 70,000 aircraft turn over in a year.

The available used fleet is aging and high insurance, maintenance, and parts costs are hastening the obsolescence of the oldest models. Bernie McGowen, publisher of the Aircraft Bluebook says "The time is fast approaching when there will be very few, near new, late model aircraft. The industry has in the past, considered 2 to 4 year old's as late models. Now, in any quantity, we are looking at 4 to 6 years and soon it will be 6 to 10 years and the age will continue to increase until new sales regain quantity."

OPERATING ENVIRONMENT FOR SEP OPERATORS

Fuel Costs

Fuel and maintenance costs have stabilized in the past three years with fuel costs actually decreasing. There is considerable spread between the wholesale and retail price of aviation gasoline. According to Department of Energy figures the wholesale price declined almost 25 percent in the period from January to August 1986, from $1.098 to 0.83. A survey of 1,200

TABLE 2-1

SINGLE-ENGINE FIXED GEAR PRICES

Aircraft	New Base Price	Used Aircraft Current Average Retail by Model Years
Taylorcraft F-21	$28,595	1970-74(F19) - $6,800-$10,700 1974-79(F19) - $9,250-$14,250 1980-84 - $15,750-$26,000
Maule M-5-180e	$39,342	1970-75(Other - $14,000-$18,500 1976-84 models)- $19,500-$35,000 1979-81 - $22,500-$25,000 1982-85 NA
Maule M-5-235C Lunar Rocket	$42,448	1977-80 - $18,100-$20,800 1981-85 - $22,900-$28,500
Maule M-6-235 Lunar Rocket	$43,148	1981-85 - $24,100-$32,400
Maule MX-7-235	$44,695	1984-85 - $28,900-$30,000
Maule M-7-235 Lunar Super Rocket	$50,665	1984 - $37,000
Cessna 182R Skylane	$80,950	1956-66 - $12,250-$19,000 1967-77 - $19,500-$32,500 1978-84 - $34,500-$71,500
Cessna U206G Stationair 6	$111,400	1978-84 - $40,500-$96,000
Cessna TU206G Stationair 6 Turbo	$124,650	1978-84 - $44,500-$107,500
Cessna 152	$45,345	1978-84 - $12,500-$32,500
Cessna 172Q Cutlass	$79,420 (1984)	1983-84 - $46,000-$56,000
Cessna T182 Turbo Skylane	$150,755	1979-84 - $48,000-$108,000
Cessna A185F Skywagon	$108,090	1973-78 - $28,000-$40,500 1979-84 - $47,000-$87,500
Cessna 207A Stationair 8	$138,065 (1984)	1980-84 - $57,000-$110,000

TABLE 2-1: SINGLE-ENGINE FIXED GEAR PRICES (CONTINUED)

Aircraft	New Base Price	Used Aircraft Current Average Retail by Model Years
Cessna Turbo 207A Stationair 8	$152,830 (1984)	1980-84 - $61,000-$121,000
Piper PA-28-236 Dakota	$123,835	1979-84 - $45,000-$81,000
Piper PA32-301 Saratoga	$196,260	1980-84 - $67,000-$120,000
Piper PA28-161 Warrior II	$78,558	1977-84 - $20,000-$52,500
Beech F33A Bonanza	$193,790	1972-78 - $54,000-$80,000 1979-84 - $86,000-$146,000
Piper PA-32R-301 Saratoga SP	$174,545	1980-84 -$78,500-$137,500
Piper A-32R-301T Turbo Saratoga SP	$190,525	1980-84 - $82,000-$145,000

TABLE 2-1 (CONTINUED)

SINGLE-ENGINE RETRACTABLE GEAR PRICES

Aircraft	New Base Price	Used Aircraft Current Average Retail by Model Years
Aeorspatiale-Socata TB-20 Trinidad	$90,800 + $8,000 ferry cost Blue book $138,000	1984 - $97,500
Bellanca 17-30A Super Viking	$125,000 Average equipment	1970-76 - $20,500-$32,500 1977-84 - $39,000-$95,000
Mooney M20J 201	$97,500	1977-80 - $44,000-$56,000 1981-84 - $61,000-$92,500
Cessna R-182 Skylane RG	$106,650	1978-81 - $38,000-$57,000
Cessna TR182 Turbo Skylane RG	$118,500	1978-81 - $48,000-$63,000 1982-84 - $75,000-$108,000
Lake LA/250 Renegade	$194,200	1983-84 - $82,500-$102.500
Beech A-36 Bonanza	$198,560 (est)	1979-84 - $118,000-$195,000
Beech B36TC	$223,708	1982-84 - $150,000-$195,000
Cessna P210R Pressurized Centurion	$235,200 (with King Avionics and Deicing. Blue book $300,045)	1978-82 - $72,500-$137,500
Piper PA-46-310P Malibu Pressurized	$371,000	1984 - $285,000

Fixed Base Operators (FBO's) by the Aircraft Owners and Pilots Association in September, 1986 showed the average retail price to the pilot of 100/130 octane aviation gasoline was $1.82 and 80 octane was $1.77.

A number of items go to make up the final retail price of aviation fuel and provide a partial explanation for the spread.

- The wholesale price, which is much higher than the price of auto gas. General aviation fuels are a drop in the barrel and are not as price sensitive at the wholesale level. The price in the spot market is sometimes lower but such purchases might jeopardize the FBO's long-term contractual supply.

- Equipment expense, which is a large part of the retail cost. An average refueling truck can cost from $20,000 to $30,000. The cost for installing fuel tanks may be $100,000 for a modest storage facility.

- Other costs, such as insurance, utilities, depreciation, and labor. There are no "self-serve" pumps. For many FBO's, insurance premiums have increased over 300 percent in the past few years.

- Lease agreements with the airport authorities usually require that the FBO's provide certain levels of service. Hours of operation and number of employees are frequently mandated. Amenities such as courtesy cars, pilot lounges, flight planning rooms and free ice and coffee are expected. They must supply high quality service and support, pay fuel flowage fees and collect federal, state and local taxes on fuel.

- Finally, with the decrease in general aviation flying, each gallon of fuel sold must contribute more toward the FBO's expenses.

Discussions with FBO's, AOPA and GAMA representatives lead to the conclusion that av gas price is not now a major deterrent to flying. Pilots have come to accept the higher prices just as automobile owners have. They do not seem to search out the FBO with the lowest price but rather look for those that provide good support services or hangar space for their plane. A significant move to automotive gasoline is not anticipated because av gas prices have stabilized and because of objections of many FBO's and airport operators to its use. In addition, Avco Lycoming, maker of the largest number of the engines on used and new aircraft strongly opposes its use.

Insurance Costs and Other Costs

Insurance costs for both the individual owner and FBO's with rental fleet have increased significantly during the last three years. One FBO stated that his insurance company had recently increased the annual rate by $100,000 with 25% less coverage. Similar reports were heard from other FBO's and some have reported restrictions on rental aircraft, requiring pilots to have higher minimum flight hours than the FAA requires. It was suggested by John Sheean of AOPA that if a pilot doesn't have retractable gear time, he will never get it because the insurance company won't let a pilot fly such a plane until he has experience. Mr. Ray Hall of Avemco Insurance Company estimated that an FBO with insurance that cost $2000 to $3000 four years ago will now pay $20,000 with lower liability limits.

Insurance for the individual pilot for a $100,000 liability limit on passengers and $1 million on property costs $356 a year. Hull insurance averages 4 to 5 percent which means it increases in dollar amount as aircraft values increase. Title insurance is also based on aircraft value; $309 on a $55,000 aircraft and $417 on a new $130,000 aircraft. This is, of course, a one-time charge but is another example of increased ownership costs. Fees for title searches, filing documents, registration, medical certificates, etc., amount to a minimum of $200. Other fixed costs that must be covered are an annual inspection at about $500, hangar storage at about $100 a month, airport landing fees of about $50, and state registration fees.

Capital Costs

In addition to the operating costs, capital costs are a major factor for today's pilot. Making a down payment and financing an aircraft that costs $130,000 or more (compared to $35,000 in 1978) is an expensive undertaking that must be balanced against other items competing for resources. It was the consensus of a number of aviation experts interviewed that $50,000 was about the maximum viable price for a single engine piston aircraft. It was their belief that buyers would come into the market at that point. One interviewee suggested that a reasonable price for a recreational aircraft was the price of a luxury sports car, and that the decline in aircraft sales occurred when the costs surpassed that benchmark.

Operating Environment

Finally, there is the "hassle factor". Today's operating environment has made flying more difficult for the recreational pilot in heavy traffic areas such as the East Coast and California. Perhaps even more important is the <u>perceived</u> hassle factor, since problems of general aviation flying in high density areas receive much publicity and are presumed to exist everywhere.

Today's deregulated airline environment has had opposing effects on the use of small aircraft for point to point transportation for business or pleasure. The availability of discounted fares and increased service to many points by both major and regional airlines has made commercial flights more competitive. On the other hand, the inconvenience and increased travel time caused by hubbing at busy major airports may discourage business travelers and make travel by private aircraft preferable.

Changes in life style have increased the number of choices available to the potential pilot. Boats, recreational vehicles expensive housing and long distance travel compete for disposable income. The shipments of recreational vehicles and motor boats are detailed in Table 2-2. Deliveries of both boats and recreational vehicles showed a sharp drop in the 1980 through 1982 recessionary period, then sales bounced back in 1983 and ended 1985 at a much higher level. (Figure 2-1) The cost of housing in the ten years from 1976 to 1986 more than doubled, taking an increasing share of income. Two worker families have limited time and recreational activities are more likely to take the form of something the family can do together.

Promotion of Flying to the General Public

There has been virtually no promotion of flying to the general public in recent years. Most advertising is in aviation media aimed at current fliers. General media advertising is specifically aimed at business travelers buying larger turboprop and jet aircraft. The introductory flights and free first lessons are no longer promoted. Cessna's Hangar 10 stores were

TABLE 2-2

RECREATIONAL VEHICLE AND MOTOR BOAT EXPENDITURES

1972-1985

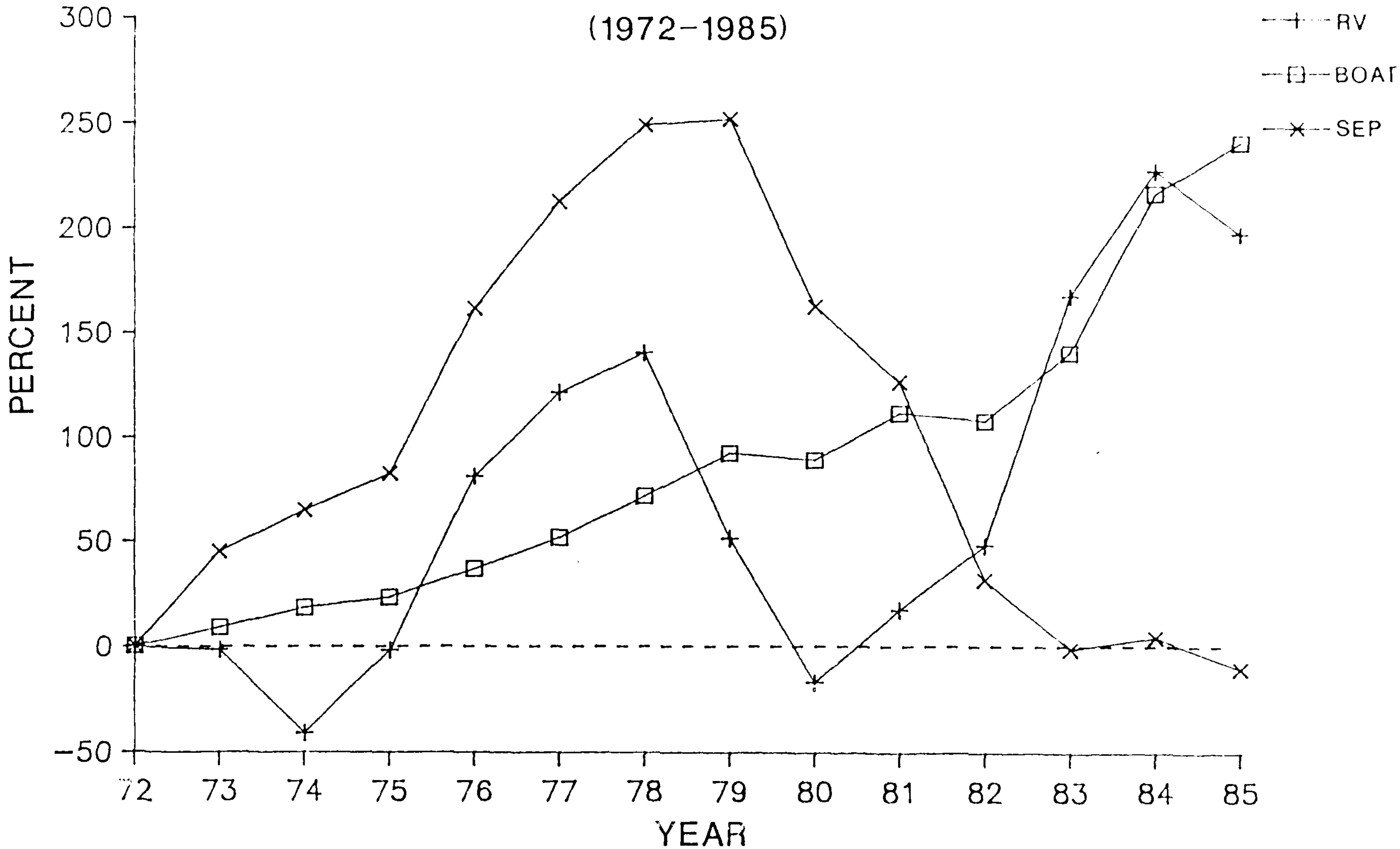
Year	Motor Boat Expenditures ($000,000)	Recreational Vehicle Expenditures ($000,000)
1972	$ 3,900	$2,365
1973	4,245	2,322
1974	4,607	1,392
1975	4,800	2,320
1976	5,333	4,284
1977	5,920	5,237
1978	6,690	5,683
1979	7,500	3,582
1980	7,370	1,951
1981	8,250	2,775
1982	8,100	3,505
1983	9,375	6,324
1984	12,340	7,773
1985	13,284	7,029

Source: Recreational Vehicle Industry Association Boat Owners Association of the U.S.

FIGURE 2-1

GROWTH OF SALES OF RECREATIONAL VEHICLES, BOATS AND SEP

(1972-1985)



SOURCE: RECREATIONAL VECHICLE INDUSTRY ASSOCIATION BOAT OWNERS ASSOCIATION OF THE U.S. FAA an attempt to market flying to the general public, with stores in shopping malls selling aviation paraphernalia and flying lessons. The project was dropped after the completion of two test stores although they were achieving limited success.

CHAPTER THREE

FUTURE OF THE GENERAL AVIATION INDUSTRY

POTENTIAL DEMAND FOR SMALL AIRCRAFT

A number of indications show that a healthy demand for small aircraft still exists. General aviation flying hours (excluding commuters) totaled 30.8 million in 1985, with 22.9 million hours flown in single engine pistons. The used aircraft market is still lively with more than 60,000 aircraft transfers a year. The Experimental Aircraft Association has 100,000 members and the Aircraft Operators and Pilots Association has 260,000 members who own 140,000 aircraft. The number of student pilots actually increased in 1986. As the fleet ages, replacement with new aircraft will become a necessity. The average age of FAA registered SEP aircraft in the U.S. is almost twenty years and the backlog of six to eight year old aircraft produced during peak production years will start running out.

Several large flight school around the country need trainer aircraft and prefer new airplanes. These include the University of North Dakota Center for Aerospace Sciences, Purdue University, Ohio State, and Embry Riddle. The University of North Dakota, for example, owns 65 aircraft, has 1,000 aviation majors, 570 flight students, and 115 flight instructors.

NEW MANUFACTURERS IN THE MARKETPLACE

Given the retreat of the large manufacturers from the single engine piston market, it is likely that some new players will enter the market in addition to the existing small manufacturers, particularly because new entries will not have a long tail of potential product liability claims. Currently two possibilities in the U.S. exist: a number of experimental aircraft that may become certificated under a new proposed FAA regulation and the De Vore Sunbird.

A proposed FAA regulation would create a new category of certification called "primary aircraft." Such a certification would make a distinction between aircraft used for sport and recreation and aircraft used for business travel and for-hire service. This could allow amateur aircraft to be certificated in a standard airworthiness category and mass produced by kit manufacturers. Current FAA regulations require that 51 percent of an amateur aircraft must be assembled by the owner. There are 13,000 of them licensed in the U.S., 2,000 built in the last two years, and another 18,000 under construction. The Experimental Aircraft Association, which represents this group of pilot-owners, is a very active organization. Kit aircraft prices range from as low as $3,900 for the Rand-Robinson Engineering's KR-2 to $43,000 for the 300-mph Swearingen SX300. Prices usually do not include engine, propeller, avionics or flight instrument purchase and installation costs.

To assess the potential of this source of aircraft, a number of kit builders were interviewed. Two of the larger companies, Zenair of Nobelton, Ontario and Fisher Flying Products in South Webster, Ohio, await approval of the new regulation. They believe it will result in a substantial reduction in the cost of certification. Zenair expects to produce an airplane for about $22,000 which would probably mean a retail price of about

$30,000. Currently, neither company carries liability insurance. Without the kind of standards set by certification, underwriters cannot judge the products. With certification, it will be possible to get insurance; however, Fisher, a U.S. manufacturer, is concerned about product liability exposure. Zenair, in Canada, where the laws discourage product liability suits, is not particularly concerned.

The De Vore Sunbird is being built by De Vore Aviation Corporation in Albuquerque, NM. It is a high-wing, composite, tricycle-gear aircraft designed primarily for the training and personal flying markets. The wing incorporates the drooped leading edge technology developed by NASA for more stability and spin resistance and its aerodynamic capabilities have been tested in NASA's wind tunnel at Langley. It is a two-seater and has a pusher propeller and a 60hp British built engine. FAA certification is expected in about 18 months. At this time, it is offered at a guaranteed factory price of $22,000, and the company has 30 deposits. If the first model goes well, it will be expanded to a four-place model with a larger engine.

Beech, although it is producing only the $132,000 Bonanza at this time, is sponsoring Sealed Composites, Inc. In that division, research and development staff is working on technology that may offer promise for simplified manufacturing processes and greater operational efficiency. Under consideration is state of the art pressurized piston single utilizing composite materials.

MARKET ENTRY OF FOREIGN AIRCRAFT

A number of aircraft are currently being produced in other countries that could move in to fill the vacuum created when major U.S. manufacturers cut back or ceased production of single engine piston aircraft. A similar situation occurred in the aircraft manufacturing industry when the leading U.S. manufacturers decided not to develop a new aircraft for the commuter market. The Beech 99 was being used by commuter airlines, but was essentially an executive aircraft and not well adapted to commuter use. Swearingen (now Fairchild) did develop the Metro specifically for the commuter market but it was still an adaptation of the executive Merlin. Meanwhile, Embraer in Brazil, Shorts in Ireland, Aerospatiale in France, deHavilland in Canada, and others decided that market growth in the commuter industry was sufficient to support development of new aircraft that would accommodate 19 passengers or more. Those foreign built aircraft are now the backbone of the commuter fleet. Foreign aircraft have also penetrated the business jet market with the French Dassault Falcon, British BAE 800, and Israeli Westwind, already in service. In 1985, business jets produced in countries other than the U.S. comprised about 34 percent of the total value of corporate jets delivered. Foreign producers have learned to compete effectively in these segments of the U.S. marketplace. One can assume they could do the same in the single engine piston market.

The framework of international trade offers both advantages and disadvantages for a company wishing to compete in the U.S. market. In many countries, foreign governments are deeply involved in the financing of design, development, production, marketing and sale of aircraft. The governments do not necessarily judge success or failure by the normal commercial standards of U.S. companies. National prestige, creation of an indigenous technology and production base and increased employment are all motivators.

Both U.S. and foreign countries must operate within the requirements of foreign trade agreements. The Agreement on Trade in Civil Aircraft, implemented January 1,1980 was designed to help reduce world barriers to aircraft trade. All signatory nations offer duty free treatment to almost all civil aircraft products. The Agreement also seeks to promote fair competition, primarily through some controls over government supports to industry. In January 1986, an agreement was reached within the Organization for Economic Cooperation and Development (OECD) on official export credits for small and medium sized aircraft. Under the agreement, loans on piston engined aircraft are limited to 5 years. The agreement also requires interest rates more commensurate with market rates. However Brazil, Australia, Indonesia and Israel have not signed these agreements although both Indonesia and Israel have expressed interest in future participation in the agreement.

Brazil's Embraer has not chosen to compete in the single engine piston market in the U.S. but does manufacture the Ipanema agricultural models and Piper kits for the South American market.

However, Embraer has the potential to produce its own models rather than build from kits. Brazil is not signatory to the Civil Aircraft Agreement. Whereas Brazil's aircraft receive duty free treatment in the U.S., the Brazilian government continues to levy duties on imports of aircraft and related products. Duties are highest on product groups that compete with equipment manufactured there. Current duties on aircraft are 20 percent plus a value added tax of 10 percent. Duties on imported parts range from 7 to 85 percent plus a value added tax of 15 percent.

Generally, U.S. trade barriers do not put foreign aircraft manufacturers at a disadvantage. Meanwhile, U.S. manufacturers are vulnerable to some tariff barriers and many non-tariff barriers and some forms of subsidy which are far less visible and more difficult to monitor. Non-trade barriers may be altered and manipulated with relative ease. U.S. manufacturers are operating in an international arena in which competitors are continually seeking ways to avoid restrictions of multilateral agreements in order to gain competitive advantage.

Product liability is currently of concern to foreign manufacturers considering entry to the U.S. market, particularly if they contemplate an assembly facility in the U.S. or any large deployment of assets to set up a support system. Generally, however, they are much less exposed because they are vulnerable only for those aircraft sold in the U.S. and do not have exposure for a large used fleet. However, to maintain credibility in the marketplace they must have adequate insurance to defend their products. They are also in a good position to sell in an expanding world aircraft market and thus spread their risk.

The level of technology achieved by foreign manufacturers enables them to compete effectively. An example is Socata's Trinidad which competes with the Mooney, one of the most advanced of U.S. single engine pistons. Mooney Aircraft Corporation, located in Texas is now owned by Eurailair International of Paris. The Trinidad is a well styled and designed aircraft and roomier than the Mooney. The manufacturing process is less labor intensive than for comparable U.S. aircraft. It takes 600 hours to build and has a 60 percent lower parts count for ease of maintenance.

Until recently, international exchange rates were to the advantage of foreign producers. Recent declines of the dollar, however, will make it more difficult for them to offer an attractive price. An attractive price and a well run marketing and support system are vital for a successful program. Aerospatiale already has a large facility at Dallas to support their helicopter program and offices and full staff in Washington, D.C. for the ATR-42 commuter aircraft. Socata, a subsidiary, has made starting efforts toward marketing the Trinidad and Tobago and a number have been sold. Socata also markets the French Robin in Europe. Aeritallia has a much smaller support staff but does have offices in Washington, D.C. and has made limited efforts to introduce the 8-passenger Partenavia. Aeritalia is considering expanding its U.S. base with the purchase of Fairchild's Metro division in San Antonio. Grob, of West Germany has a facility in Bluffton, Ohio and a dealer network for its gliders and motor gliders. British Aerospace has an extensive sales and support staff for its commuter aircraft and business jets. Although it manufacturers no small aircraft itself, it could lend marketing support to other British companies such as ARV Aviation. The ARV Super 2, a two-seat trainer certified by the British CAA is in production priced at the equivalent of $44,000 in England. At this time ARV is hesitant to enter the U.S. market because of the difficulty of obtaining product liability insurance and its high cost.

It must be added that the rapid internationalization of the aircraft manufacturing industry in both the air transport and general aviation categories has somewhat neutralized competition. Many U.S. parts and engines are used in foreign aircraft and vice versa. Aerospatiale's Trinidad is an example. It has U.S.-made engines, propellers, brakes and avionics--an estimated 82 percent of the total cost of component parts.

Table 3-1 lists the foreign companies that are producing or developing single engine piston aircraft, which could compete for the American market.

FUTURE TECHNOLOGY FOR GENERAL AVIATION AIRCRAFT

Very little innovation has occurred in aircraft and engine design for small general aviation aircraft since World War II. The design of the majority of today's small piston fleet is based on aeronautical science that was developed before and during the war. Recently, however, spurred by the increased cost of fuel and by advances in transport and space vehicles transferable to small aircraft, more attention has been devoted to technological

TABLE 3-1

FOREIGN COMPANIES PRODUCING OR DEVELOPING SINGLE ENGINE PISTON AIRCRAFT

Country	Company	Aircraft	Status	Estimated Price
Brazil	Embraer	Ipenema-Agric. Piper Kits (Archer Saratoga Seneca III Arrow)	In production For sale in Brazil	n/a
France	Aerospatiale Socata	TrinidadTB 20 Trinidad TC Tobago TB	In production FAA certified	$140,000 155,000 85,000
	Robin	Robin-3000 and Bijou	In production	n/a
Italy	Aeritalia Agusta Siai Marchetti	Mosquito, 2 seat Four seat Aerobatic	In production In production FAA certified	$35,000 $210,000
United Kingdom	ARV Aviation Isle of Wight	ARV Super2 New Hewland engine	In production CAA certified Four seat in development	£ 26,000 (~$44,000)
	Nash Aircraft Ltd.	Nash Petrel two seat low wing	5 models being tested for CAA	n/a
	Trago Mills	Trago Mills SAH I Aerobatic	CAA certified in production	n/a
W.Germany	Grob Systems	Grob G115 two seat four seat planned	FAA certified late 1987	DM 145,000 (~ $80,000)

improvements. Such improvements would add features that aren't available in the current fleet of used aircraft and could generate new purchases.

The National Aeronautics and Space Administration (NASA) has been involved in research for general aviation aircraft for many years, striving for improvements in efficiency, safety and environmental compatibility. Most of the research has been done at NASA's Langley Research Center at Hampton, VA., while propulsion research is done at Lewis Research Center in Cleveland. NASA also works with universities and industry. NASA allocated $9.4 million to general aviation research in 1986 and has projected about the same amount for 1987, approximately 2.5 percent of the total budget.

Airframes

NASA and the manufacturers are attempting to redesign the fuselage to reduce drag by promoting natural laminar flow and to incorporate structural concepts based on the strength and weight advantage of composite materials. Composites offer a potential weight reduction of up to 30 percent. The favored composite materials are carbon fiber reinforced plastic (CFRP) and Kevlar. Production cost is a major problem in using composites since retooling plants and retraining workers is expensive. Over the long term, however, more automation is possible with composites than with metal. Two larger, all-composite aircraft under development are thé Beech Starship and the AVTEK 400. Both are twin turboprop designs with canard surfaces and high cruise speeds. They are radical departures from the general aviation norm, but as yet no manufacturer has indicated a willingness to build an all-composite single engine piston aircraft.

Experimental aircraft have been using composites extensively for some time. Kit builders can incorporate advanced technology such as composites more quickly because of the absence of certification requirements. Less conventional configurations such as canard wings and winglets are also used on experimental aircraft.

Wings

Improvements in wing design and construction are directed toward achieving natural laminar flow with smooth contours and surfaces. Composites offer much promise and are already in use in wings of a number of aircraft. Winglets reduce vortex drag by producing a forward lift component and at high lift they significantly increase lifting surface of the wing although there is a weight penalty. Winglets offer great potential for decreased fuel consumption and higher performance but the winglet must be tailored specifically for each design.

Propellers and Engines

Propeller research has focused on improving efficiency and reducing noise, both interior and exterior. Some of the concepts being explored are elastic pitch change, use of composites and pusher propellers, as used on the Voyager experimental aircraft.

NASA propulsion research has centered on improving efficiency and reducing noise and exhaust emissions in general aviation engines. NASA conventional piston engine research involves applying existing technology to improve fuel economy by leaner operation, drag reductions, and flight at high altitude. Reduction of exhaust emissions and engine installation drag, improved fuel injection systems and cooling methods, and advanced turbochargers are part of these efforts as well. Turbocharging can extract more power from a given engine displacement and maintain power from sea level to high altitudes. Currently a Lycoming engine flying in the high-altitude Mooney M30 and a Continental in the high-altitude Piper Malibu, are both using Garrett turbochargers.

The use of advanced materials such as titanium and a small amount of reinforced plastic and ceramics offer potential for reducing engine weight as much as 30 percent. Advanced engines constructed of such materials also allowed higher service ceilings, 25,000 to 35,000 feet, and time between overhauls can be increased from 1,400 hours to 2,000 hours.

For the future, the major areas for research are durability to reduce maintenance and fuel consumption. To improve fuel consumption, changes may be made in the combustion system, timing and in the electrical system. Avco Lycoming is working on a high turbulence system of fuel-air mixing to boost fuel efficiency. Advances may also come in electronic fuel injection for aircraft engines.

An important advance for general aviation would be the development of a multi-fuel engine. Aviation gasoline is expensive and unavailable in many parts of the world. One alternative is automotive gas but it is lower octane and at this time does not have a high enough level of quality control. Jet fuel is available worldwide and costs less but must be run in a diesel-type engine. It is possible that a small low cost turbine engine could supplant the piston engine in applications above 300 horsepower. This would only be suitable for the largest and most expensive single engine aircraft. The small stratified charge turbocharged rotary engine appears to offer the most hope. The stratified charge feature permits two levels of fuel richness in a combustion chamber. A small charge of a rich mixture is ignited, which then fires the remainder of a charge that is too lean to ignite easily. The engine would burn jet fuel with an advanced version that could have multi-fuel capability, would be liquid cooled, and have low fuel consumption and low profile drag.

Avco Lycoming was working on such an engine with John Deere Technologies International. Unfortunately, this program had a setback when Lycoming (a subsidiary of Textron, Inc.) decided to stop funding development. John Deere is continuing the program for the aircraft engine and looking for a partner to replace Lycoming and assist in marketing and distribution. They expect to have a 400 hp engine ready for testing by May 1, 1987. This engine is expected to cost about $35,000, about one-third what a turbine engine of similar power would cost. This 400 hp engine is too large for small single engine aircraft. However, the company is working with NASA Lewis Research Center on 100 hp and 170 hp engines. They expect to have the smaller engine ready for testing in 1988, and hope to price it at about the same level as a reciprocating engine of the same power. It will be more fuel efficient and is designed for multi-fuel capability but

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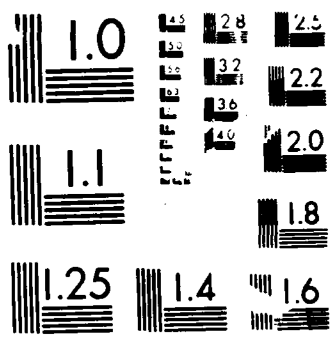


MICROCOPY RESOLUTION TEST CHART
NBS 1963-A

is particularly intended for the less expensive and more widely available jet fuel.

Teledyne Continental is also working on a small rotary 100 hp engine through a licensing agreement with Norton Motors Ltd. of England. Its first use is expected to be for remotely piloted vehicles and ground use. When the engine is fully tested in about two years, however, Continental will apply for small aircraft certification. It will be designed to price at about $6,000. Such a price would be a strong support to bringing small aircraft prices down. The company believes there is a need for a trainer/recreational level aircraft and that there is an important market for such an aircraft.

A number of these technological advances are directed toward bringing down cost of airframes and engines and improving the operating efficiency. Most are in use or in the advanced testing stage and could have an early impact on the market because they have the potential for lowering price and for offering substantial innovations that would make new aircraft attractive to buyers. Perhaps the most depressing factor is the high cost of product liability insurance which discourages manufacturers from offering new products.

FORECASTING RECOMMENDATIONS

The implications of this study for forecasting single engine piston sales are:

- Sales will gradually increase at such time as the current surplus of low time used single engine piston aircraft is absorbed or older aircraft become obsolete.

- Sales would be favorably affected by the introduction of a lower priced technologically improved product that significantly decreases the cost of flying. This possibility exists today. The introduction of a product which improves performance but does not significantly lower costs will have much less impact, except at the high end of the market.

- Sales will never return to the peak of 1979-1981 unless a similar set of circumstances reoccurs, including high inflation and an event such as the GI Bill, which encouraged entry of new pilots and put a time constraint on the period of eligibility. The annual demand for single engine piston aircraft for direct use has average 7,000 to 9,000/year historically. The average is unlikely to exceed that figure in the future.

- The aging of the population will further dampen single engine piston sales, as will the competition for the recreation dollar, changing life styles, increasing urbanization, and the availability of inexpensive commercial air travel.

It is recommended, based on these conclusions, that current econometric forecasting methods used for general aviation activity be supplemented with more pragmatic forecasting techniques based on rate analysis. The current rate of pilot participation of the population can be extrapolated based on census data, as a check on econometric forecasts. It can be assumed that the rate is relatively constant, changing only when circumstances that affect the rate, such as a substantial cost variation, change.

Recreational flying is an easily deferrable activity. Therefore, there is a price elasticity to flying and to purchasing aircraft which should be considered in developing forecasts. Both operating costs and aircraft price have moderated somewhat recently, but the real increase in costs over the last 15 years has been very significant. A high elasticity of -8.4 for aircraft prices and -7.6 for operating costs was found in the regression analysis. Therefore, all of the costs of flying should be carefully monitored as factors strongly affecting the rate of participation.

Recreational flying has become an activity that has a predominance of high income participants. Significant growth in recreational flying activity would require a decline in costs sufficient to access a market further down the income curve. Since income distribution is a reasonably normal distribution, the size of the market increases rapidly as costs decline. It similarly decreases rapidly as costs increase. Attention to the actual costs per hour of operating a single engine piston aircraft is, therefore, very worthwhile in developing forecasts.

CHAPTER FOUR

FLIGHT SERVICE STATIONS

INTRODUCTION

Flight Service Stations (FSS's) are FAA's point of contact with pilots before and during flight, complementing the Air Traffic Control facilities and providing weather and other information by telephone and radio. This study addressed Flight Service Stations as a particular issue in the forecasting of general aviation activity because FSS's are experiencing several major structural changes, including the changes in single engine piston activity. The current workload measures and forecasting techniques are not adequate to the task of developing estimates of future workloads. FSS's are in the middle of a process of automation and consolidation, which will reduce the number of FSS facilities by a factor of five and reduce the Flight Service Specialist time necessary for many of the FSS functions.

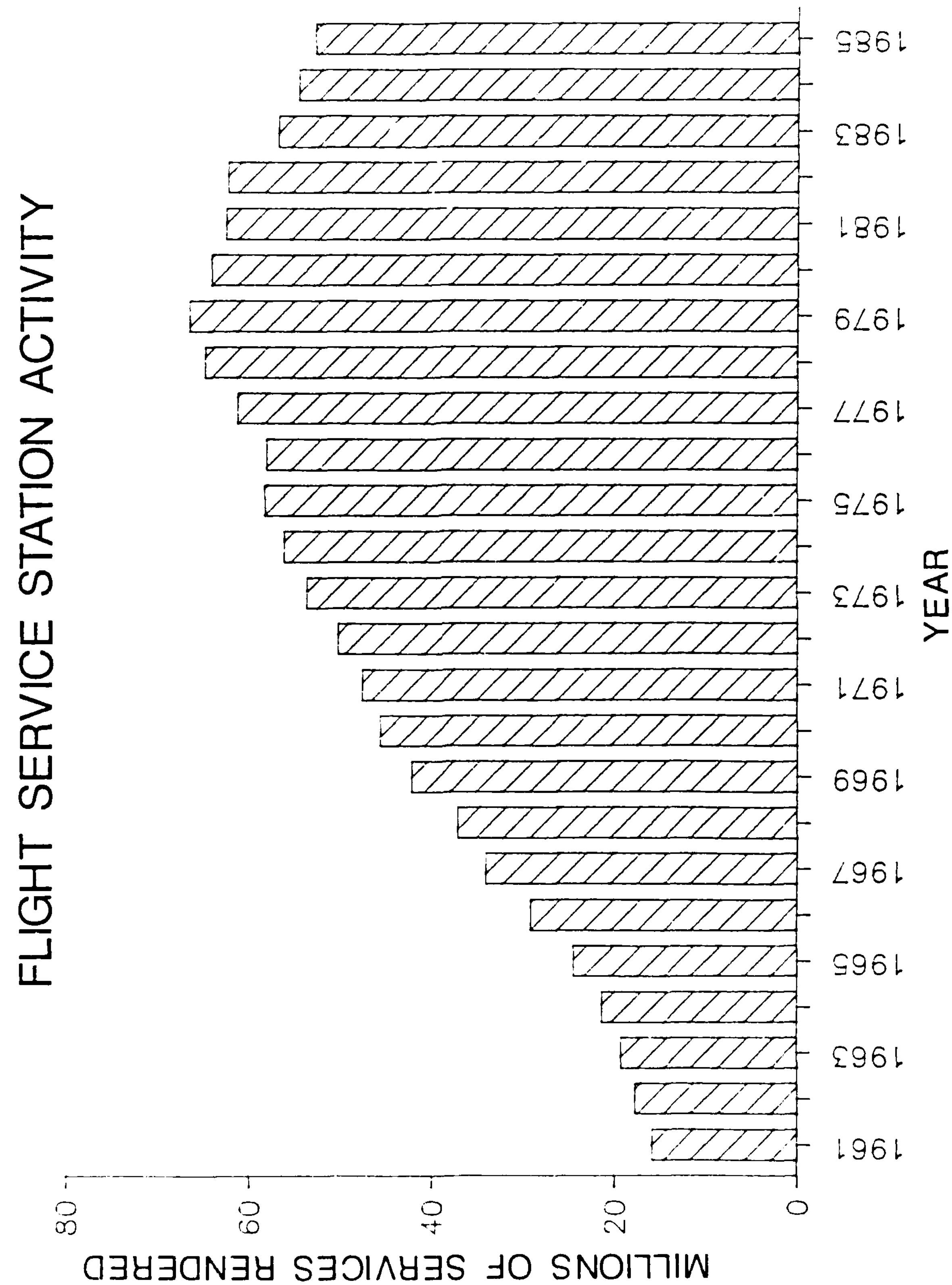
The activity of FSS's is measured counting three activities: pilot briefings, flight plans filed, and aircraft contacted. These data are the only available data on FSS activity. In recent years, those activities have declined (Figures 4-1 and 4-2). These declines are not solely a function of a drop in general aviation activity.

FLIGHT SERVICE STATION WORKLOAD MEASURES

Forecasts of flight services are prepared for pilot briefs, flight plans originated (IFR and DFR) and aircraft contacted. Total flight services are not the additive total of these three measures, but are calculated according to a weighted formula:

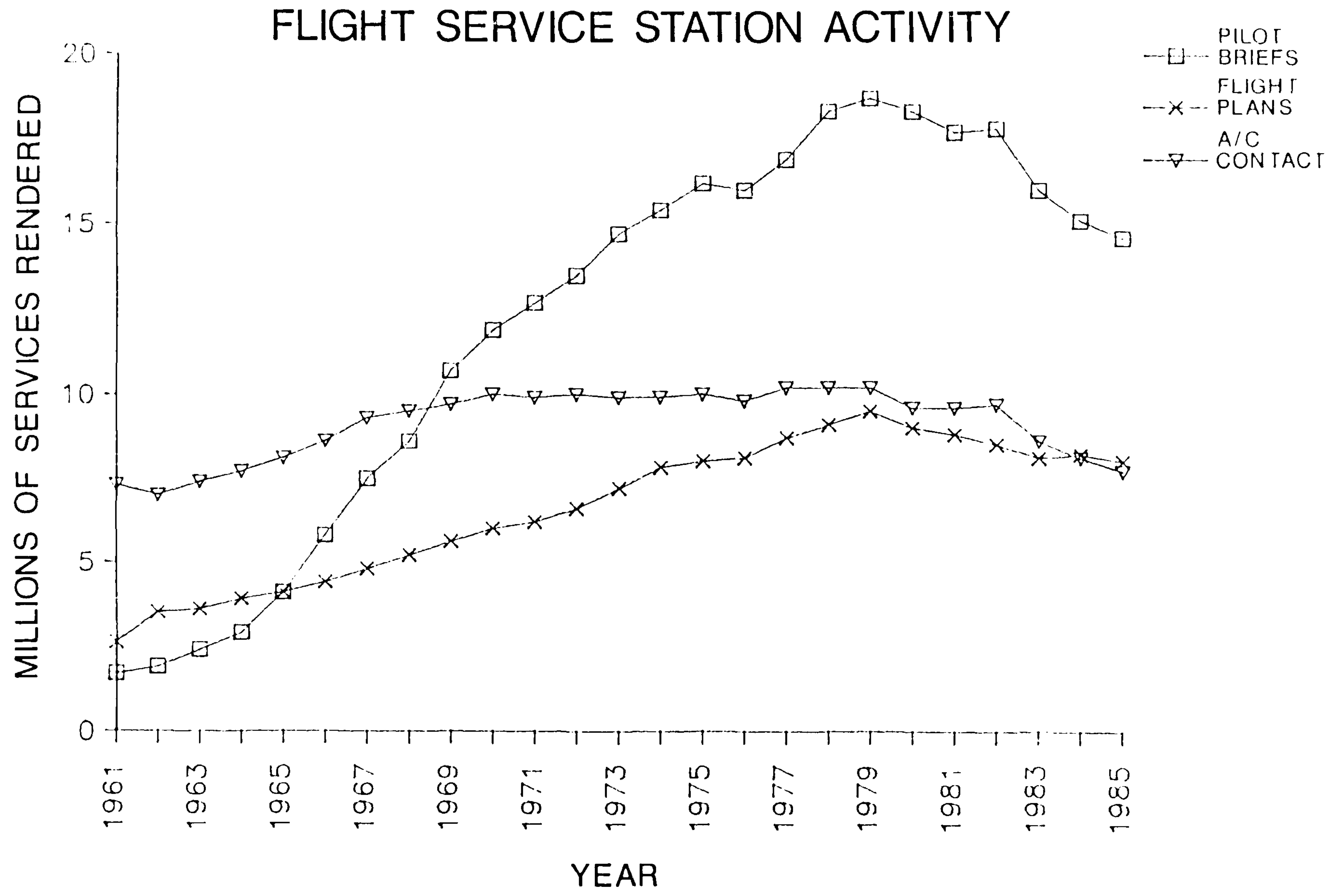
FIGURE 4-1

FLIGHT SERVICE STATION ACTIVITY



SOURCE: FAA STATISTICAL HANDBOOK OF AVIATION

FIGURE 4-2



SOURCE: FAA STATISTICAL HANDBOOK OF AVIATION

$$\text{Flight Services} = 2(PB + FP) + AC$$

Where:

PB = pilot briefs,
FP = flight plans filed, and
AC = aircraft contacted.

In the Flight Service Station Privatization Evaluation Report,[1] COMSIS identified 38 functions performed by specialists (Table 4-1). However, 4 of those functions were identified as services that would end with consolidation, so the relevant number of services to consider is actually 34. Those functions were divided into several broad categories, which have some overlap: on-ground pilot services (10), ground-to-air pilot services (10), emergency services (5), data services (8), and public services (1).

A number of functions identified are listed in more than one category, which may have been appropriate for an evaluation of the services private companies might be willing to assume. In those cases, there was a valid distinction between on ground pilot services and ground-to-air pilot services. Such a distinction would not be relevant if both functions were performed by FSS specialists; correction for this double counting reduces the number of distinct functions to 30:

4/19	Close flight plans
8/15	Relay clearances
9/16	Provide Special VFR Clearances
10/10	Provide flight services for special events

---

[1]COMSIS Corporation, et al., **Flight Service Station Privatization Evaluation**, prepared for the Federal Aviation Administration, June 1987.

TABLE 4-1

FLIGHT SERVICE STATION SERVICES

On ground pilot services

1. Conduct preflight pilot briefings
2. Process preflight IFR flight plans
3. Process preflight VFR flight plans
4. Close flight plans
5. Process international flight plans
6. Advise Customs of international arrivals
7. Prepare PATWAS and TWEB recordings
8. Relay clearances
9. Provide Special VFR Clearances
10. Provide flight services for special events

Ground-to-air pilot services

11. Conduct in-flight weather briefings
12. Provide Enroute Flight Advisory Service
13. Process in-flight IFR flight plans and modifications
14. Process in-flight VFR flight plans and modifications
15. Relay clearances
16. Provide Special VFR Clearances
17. Provide flight movement and air traffic control messages
18. Conduct hazardous reporting service
19. Close flight plans
20. Provide flight services for special events

Emergency services

21. Initiate and participate in Search and Rescue
22. Monitor emergency radio frequencies
23. Assist pilots in distress
24. Assist in the location of ELT transmissions
25. Develop airport emergency plans

Data services

26. Process Notices to Airmen (NOTAM's)
27. Process Pilot Reports (PIREP's)
28. Process military mission information
29. Contribute to law enforcement activities
30. Maintain a data base for legal and administrative purposes
31. Prepare accident data packages
32. Transmit administrative messages

TABLE 4-1 (CONTINUED)

Public relations services

33. Liaison with area airports
34. Perform public service functions

Services that will end with automation

35. Monitor navigation aids
36. Provide airport advisories
37. Perform weather observations
38. Operate airport equipment

Sources: FAA manuals and field observations.

In practice, the three measured flight services used in the FAA counts and forecasts each encompass several of the 30 identified functions.

Pilot Briefs include the following functions:

1. Conduct preflight weather briefings
10/20. Provide flight services for special events
11. Conduct in-flight weather briefings
12. Provide Enroute Flight Advisory Service

Flight Plans originated includes the following functions:

2. Process preflight IFR flight plans
3. Process preflight VFR flight plans
5. Process international flight plans
10/20. Provide flight services for special events
13. Process in-flight IFR flight plans and modifications
14. Process in-flight VFR flight plans and modifications

Aircraft Contacted includes a variety of functions that may be performed singly, as one aircraft contact, or together, as several aircraft contacts counted as one aircraft contacted, including all those functions identified as ground-to-air pilot services:

4. Close flight plans
6. Advise customs of international arrivals
8. Relay clearances
9. Provide special VFR clearances
10/20. Provide flight services for special events
11. Conduct in-flight weather briefings
12. Provide enroute flight advisory service
13. Process in-flight IFR flight plans and modifications
14. Process in-flight VFR flight plans and modifications
17. Provide flight movement and ATC messages
18. Conduct hazardous area reporting service
23. Assist pilots in distress
27. Process pilot reports (PIREP's)

There is an overlap between aircraft contacted and both pilot briefs and flight plans originated that may result in some double counting. For example, a flight plan that is filed enroute will count as both an aircraft contacted and a flight plan originated. The magnitude of this double counting is unknown.

Emergency services are very important functions, but they are difficult to count because emergencies are so infrequent. It is also difficult to isolate the individual emergency functions, because they are interconnected. Monitoring emergency radio frequencies (22) will, in the case of an emergency, lead to an assist to a pilot in distress (23), and both of these will also be considered in the aircraft contacted count. Search and rescue (21) activities are initiated by a series of events following a flight plan that is not closed or the receipt of an Emergency Locator Transmission (24).

The workload created by the provision of emergency services will always, by their nature, be measured as potential activity rather than as the result of actual occurrences. Emergency services are passively provided as a back-up to the system and are only activated by an emergency. The importance of that back-up system cannot be measured solely by the number of emergencies that occur; any count will underestimate the value of those services in saving lives and property.

Developing airport emergency plans (25) is a minor function for which FSS's share responsibility and would be more appropriately considered a public service function (34), as would liaison with area airports (33).

Flight service stations also provide a large number of administrative services, which were characterized in the Privatization Study as data services. Several of these do not reflect any demand for flight services, but tie the FSS's to the rest of the FAA airspace system:

29. Contribute to law enforcement activities
30. Maintain a data base for legal and administrative purposes
31. Prepare accident data packages
32. Transmit administrative messages

This review of the functions of the flight service specialists demonstrates that there are several functions that are not counted, and a number of others that are either partially or inappropriately counted. Counting these service provided to pilots will better describe the actual operations and workloads of FSS's as discussed in the following sections.

Close Flight Plans

Flight plans originated are one of the three current workload measures, but *closing flight plans is not counted* except as an aircraft contact, which may not create an additional count. The formula does weight flight plans double, but if that weighting is intended to count flight plan closings (on the assumption that there will be a closed flight plan for every originated flight plan), it overestimates IFR flight plans, which are often closed through a center and not an FSS.

This overestimation of IFR flight plans is exacerbated by the fact that VFR flight plans entail a greater specialist workload. An IFR flight plan is passed to the center, a one-step process, and at some FSS's many IFR flight plans are filed automatically by regional airlines and major air carriers on a regular and repetitive basis. In contrast, VFR flight plans must be processed, activated, passed on to the destination FSS and closed. In addition, these flights are monitored so that, if a VFR flight plan is not closed, a series of emergency steps are taken. Separate counts and forecasts of VFR and IFR flight plans originated are made, but the totals are then aggregated and entered into the workload formula. A separate counting and different weighting may be appropriate.

Prepare PATWAS and TWEB Recordings

These are recorded weather briefings and do not involve contact with a flight specialist. The specialists' workload consists of recording periodic updates of the messages. This is not an insignificant use of specialists' time because the recordings are updated every hour, and this typically takes about five minutes (or 8.5% of one specialist's time).

The demand for this service is unrelated to the workload on the specialist, however, for once the message is recorded, it doesn't matter if one or one hundred pilots access the message. Because the workload does not vary with demand but is constant, the inclusion of this measure would add stability to the workload forecasts and reduce their variability. With consolidation, the number of recordings at a single FSS are increasing significantly and requiring a significant personnel allocation, for which no "credit" is received using current workload measures.

The actual use of PATWAS and TWEB messages may, however, be an indicator of the use of other flight services. To what degree these recordings may substitute for a pilot brief or an aircraft contact is not known, nor do we know if this relationship has changed over time. For example, in may be that pilots will use a combination of private weather briefings and PATWAS and TWEB recordings to substitute for a pilot brief, so that the impact on the number of pilot briefs would be related to the use of these recordings (i.e., neither by itself would substitute for a full pilot brief, but in combination they would).

With increasing automation, better recording equipment will enable information to be updated more frequently, which may add to the specialists' work load and may also provide better service to pilots. With full automation, however, these recordings will be prepared automatically, without specialist involvement.

Process Notices to Airmen (NOTAM's)

NOTAM's contain important aeronautical information that is often crucial to safe flight. The processing, dissemination, and cancellation of a variety of NOTAM's is an important administrative function performed by flight specialists. NOTAM's are included in a standard weather briefing, but the time spent in preparing them is not accounted for. Maintaining records of this activity would be a minor administrative effort.

Process Pilot Reports (PIREP's)

Flight service specialists solicit pilot reports during other contacts with pilots, both before and after flights, on the ground and in the air. Air-to-ground reports are counted as an aircraft contact, but because they are associated with another aircraft contact this does not increase the measured workload (aircraft contacted). Specialists also process and disseminate PIREP's. The number of PIREP's processed would vary with weather conditions in the same way that pilot briefs do and contribute to the peaking problem that affects all specialists.

Other Functions that are Included in the Current Measures

In addition to these suggested additional counts, a reorganization of the three current workload measures may be appropriate. As noted above, these three workload measures include a range of functions, many of which are not comparable.

- Four kinds of weather briefings are counted equally: standard briefings, abbreviated briefings, outlook briefings, and EFAS briefings. Each of these generates a different workload.

- In addition, one weather briefing cannot be compared to another; a local forecast counts the same as a cross-country forecast. It was suggested to us in our visits to local FSS's that one way to measure these differences would be to automatically count the number of lines used in a particular briefing and use those counts to weight them.

- An aircraft contacted may include as many as 30 aircraft contacts, in the case of a Direction Finder (DF) assist to a disoriented pilot, or a single contact that includes a flight plan filing and generates a count of three flight services.

- Aircraft contacted is such a general term that it includes, as noted above, a wide range of disparate functions, most of which are not otherwise counted.

FACTORS AFFECTING FLIGHT SERVICE STATION WORKLOAD

Private Weather Briefings

It is currently possible and permissible to obtain a weather briefing from sources other than the FSS. Available sources include the National Weather Service, public television's Aviation Weather Report, and private providers. Approximately six private providers of weather data communicate with pilots using computers and remote terminals. They charge for the connection, and provide all of the information available at FSS's from the national database. They do not have access to local NOTAM's. They can also provide weather maps and computer generated flight plans. They cannot currently file flight plans with the FAA on behalf of the pilot. They currently provide between 5 and 10 percent of the weather briefings that the FSS's provide.

Current FAA policy is to develop a mechanism whereby all pilots will be able to avail themselves of these automated services at no cost, to obtain the same data they obtain from the FSS, and to file flight plans automatically. This policy is recent; the date of its implementation is uncertain. At such time as it occurs, there will be a drop in FSS services because pilots may choose to use their personal computers to communicate with private providers.

The Minnesota Department of Transportation is sponsoring a program that provides pilots with access to computerized weather briefings at no cost. The state has placed terminals at FBO's and other airport sites at 56 locations. The terminals and the service are leased from Kavouras, Inc., a private firm. Analysis of Minnesota DOT and FAA statistics indicate that about one-third of all weather briefings obtained in the state during a recent period were provided automatically. This appears to represent a reasonable assumption of the extent to which automated weather briefings will replace specialist provided briefings nationally if universally available free services were available, especially if terminals are provided by FBO's.

Voice Response System

FAA has developed a voice response system for obtaining weather briefings from a computer generated voice system over touch tone telephones. The pilot dials a toll free number and responds to the instructions by entering codes describing the type of briefing desired and the airports of interest. Private providers have also developed voice response systems. FAA has installed an Interim Voice Response System (IVRS) in 16 cities as a developmental program. They have gathered data from the sixteen cities to determine potential use of the system. These data are shown on Figure 4-3. Analysis of Interim Voice Response System statistics from 16 cities indicates that these automated telephone weather briefings will replace about 5 percent of specialist provided briefings.

Consolidation and Automation

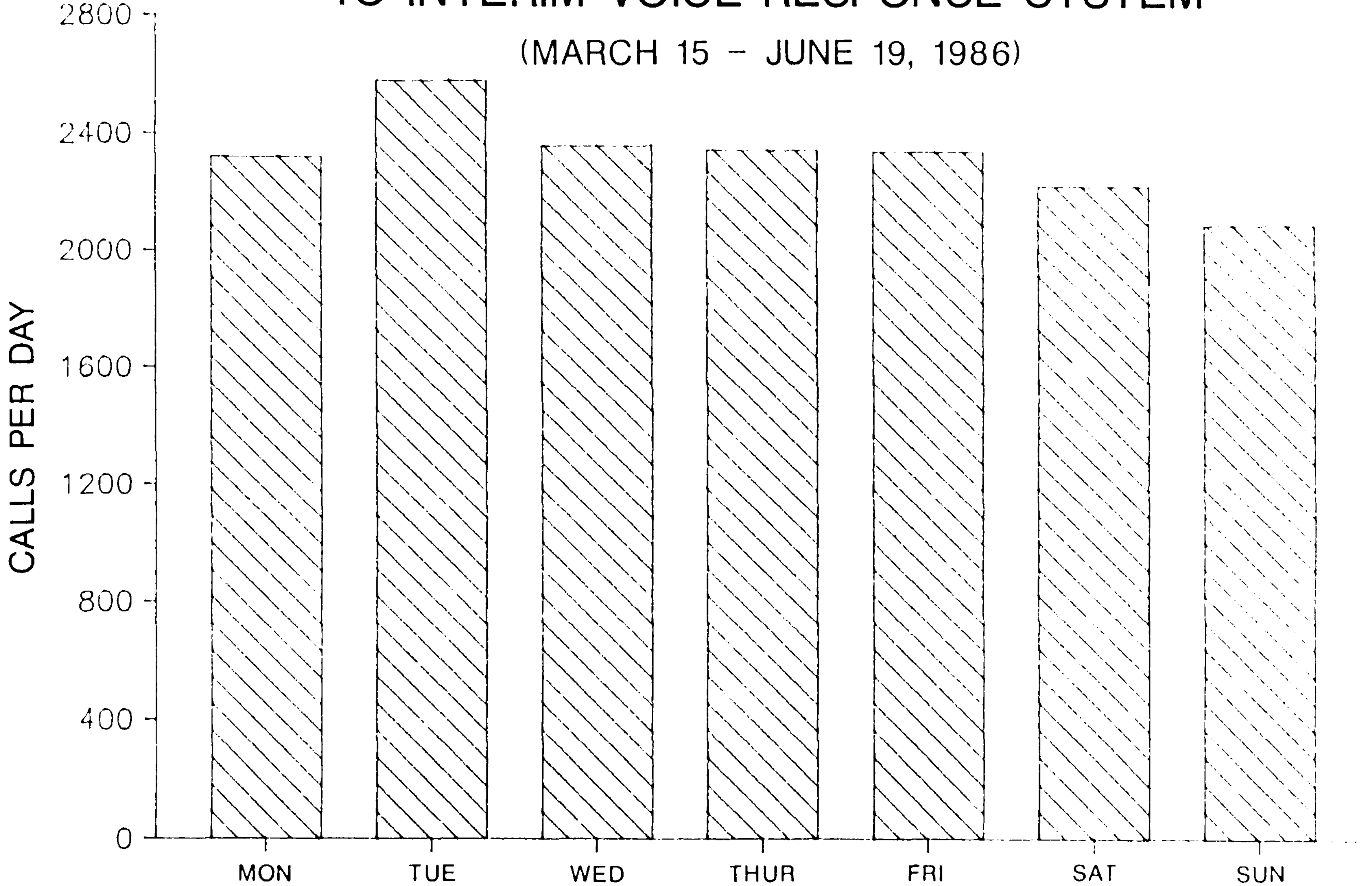
FAA is currently consolidating the FSS operation from over 300 locations to less than 100 Automated Flight Service Stations (AFSS). The process includes the construction of new consolidated facilities, which are being equipped with automated equipment that simplifies and expedites the specialists responsibilities. This consolidation and automation program has had delays due to equipment and funding problems, but is proceeding and will have an impact on the FSS workloads.

Many pilots have complained about being unable to get through by telephone to the flight service stations. They say that they eventually give up. Therefore, some of the potential demand for flight services is not being satisfied at the same

FIGURE 4-3

AVERAGE DAILY CALLS TO INTERIM VOICE RESPONSE SYSTEM

(MARCH 15 - JUNE 19, 1986)



SOURCE: FAA

time that counts are declining. Because flight service stations do not have the ability to track delayed and lost calls, however, the truth of these claims and the magnitude of the problem is impossible to measure. With consolidation and automation the new systems will be able to handle a higher volume of calls to the FSS and fewer calls will be lost. In addition, the reduced holding times and greater accessibility will provide a higher level of service than is now available, which should result in more flight services being provided. How many more services is difficult to estimate.

Where flight schools are located at airports with an FSS, familiarization with the procedures of using an FSS and the services that are provided by an FSS are included in the training process. It is sure to include a tour of the FSS, an introduction to some of the flight specialists, and a demonstration of the services that are available. Through this process, the novice pilot grows comfortable with using the services provided by FSS's and develops a propensity to use those services throughout his flying career. When the FSS's are consolidated and the services are provided by strangers over the telephone or radio only, the pilot will be less familiar with the service offered by FSS's and may be less likely to use flight services later.

Many pilots view the local FSS as part of their community and are friends and neighbors of the flight specialists. They actively support the local FSS, partly by using the services they provide. When FSS's are no longer located in the communities that they now serve, this local support will no longer exist and the total demand for flight services will decline.

Automation is being held up by lack of moving funds and, in some cases, funds for leased communications lines. Automated stations are not as efficient without consolidation. Training has become a serious problem, and new equipment cannot be efficiently used until training is completed. For training to proceed expeditiously, staff members need to live in the local area.

In terms of financial impact, savings from AFSS come mostly from consolidation. AFSS's can provide the same services with fewer people, especially during slow shifts when one specialist at the consolidated facility replaces one at each of the existing facilities.

Aircraft Contacted

Because of the way that aircraft contacts are aggregated as aircraft contacted, with the consolidation of flight service stations and the consequent expansion of flight plan areas, the number of aircraft contacted will decrease even if the number of aircraft contacts does not. The magnitude of this change will depend on the degree to which aircraft that previously dealt with more than one FSS on a flight will now deal with only one consolidated FSS. This means that the ratio between aircraft contacts and aircraft contacted, which is now known and tracked, will change.

Flight Training

Flight training accounts for a substantial percentage of the demand for flight services. In some area , such as Florida and California where a lot of flight training takes place, it accounts for the majority of the flight services. By its very nature, training of students requires multiple pilot briefs and aircraft contacts. As students advance in their training they will also file large numbers of flight plans. The sharp decline in the number of flight schools and student pilots accounts for some part of the declining use of FSS services.

Student and novice pilots, the least experienced general aviation pilots, tend to account for a disproportionate number of flight services. A student or novice pilot is more likely to request one or more weather briefings, to file and close a flight plan, and to need assistance in the air. Therefore, a decrease in the number of student pilots (and shortly thereafter, novice pilots) will also lead to a disproportionate decrease in the demand for flight services.

Regional Airlines

Regional airlines account for large numbers of IFR flight plans filed at some FSS's. The rapid growth of these regionals since deregulation in 1978 may have, in selected areas, distorted the count of IFR flight plans. When these regionals move to direct filing, demand appears to have declined dramatically. A good example of this trend and the distortion it creates is the Cincinnati, OH Flight Service Station. Comair, an aggressively expanding regional based in Cincinnati and affiliated with Delta had filed its IFR flight plans through the Cincinnati FSS, but this year began to file them directly with the Indianapolis center. The counts of IFR flight plans filed there dropped dramatically:

1982:	30,000	----
1983:	54,000	+ 80%
1984:	91,000	+ 69%
1985:	112,000	+ 23%
1986:	36,000	- 68%

Without Comair's abnormal growth included in the counts, the FSS showed a reasonable increase of 20 percent in IFR flight plans originated from 1982 to 1986.

The advent of regional airlines affiliation with major carriers will speed this process of automated flight plan filing, as the major carriers provide technical services for their affiliated regionals. Major carriers nearly all have direct ties into the ARTCC Computer for flight plan filing. At some FSS's, this shift will cause a dramatic decline in the number of IFR flight plans filed by FSS's without causing a significant drop in actual work load.

Military Aircraft

Military aircraft are required to file IFR flight plans for every flight. These flight plans have always been filed with the FSS. The Department of Defense is automating that process so that all military airfields will have facilities for directly inputing flight plans to the ARTCC computer. As with the regional carriers, this will cause a sudden large decline in IFR flight plans filed for the FSS's that serve large military bases, without as great a decline in actual work load.

ALTERNATIVES TO CURRENT WORKLOAD MEASURES

Based on the changing structure of the FSS activity and the inability of the current workload measures to respond to that structure, a number of alternative workload measures are suggested for consideration:

- Count broadcasts prepared (TWEB, PATWAS) as a workload measure. These are dependent on the number of outlets and the weather, not flying activity and are not evenly distributed around the country. Preparing broadcasts will become a full time effort at some FSS's after consolidation.

- Differentiate between IFR and VFR flight plans in the counts. VFR flight plans are a more time consuming responsibility for FSS's, and this disparity in effort will increase after automation.

- Count NOTAM's (Notices to Airmen) prepared. This is a service unrelated to flying activity that varies around the country.

- Count PIREP's (Pilot Reports) processed. A currently uncounted activity that peaks during times of inclement weather.

- Distinguish among different kinds of weather briefings:

    - Standard
    - Abbreviated
    - Outlook
    - EFAS
    - Local or cross country

  Each of these entails a different effort. Counting the lines on the terminals may be a better way to measure activity than simply counting briefs.

- Count aircraft contacts instead of aircraft contacted. A DF Assist can be 30 contacts and take 30 minutes of time. Most contacts are much less time consuming.

- Count Saves as an activity.

RECOMMENDATIONS FOR FORECASTING

Forecasting FSS activity based on current workload measures will require some major adjustments to the base data because of the structural changes discussed above. Historic data can be factored to adjust for automation, consolidation, access to private sources, the voice response system, and automated filing by regionals and military aircraft. These factored base data can be used in forecasting based on the forecasts of general aviation activity. They should change in proportion to the changes in hours flown, perhaps with some adjustment for student activity. Additional adjustment will be necessary if there are significant changes in the ratio of VFR to IFR activity over time.

Before any alternative workload measures can be forecast it will be necessary to begin counting them in order to develop some historical data as to the magnitude of the activity. With automation, many of these data are more easily counted. Even with historic counts, it will be necessary to adjust the base data to account for the structural changes as they occur.

FSS activity will decline in the next ten years, no matter what workload measures are used. This decline is largely a result of automation and improved productivity. A continuing drop in the level of general aviation activity will accelerate the decline, but even if a boom in general aviation flying were to occur, the work performed at FSS's will decrease.

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APPENDIX A

ORGANIZATIONS CONTACTED FOR STUDY

APPENDIX A

ORGANIZATIONS CONTACTED FOR STUDY

Cessna Aircraft Corporation, Wichita, KS

Beech Aircraft Corporation, Wichita, KS

Piper Aircraft Company, Vero Beach, FL

Bellanca Aircraft, Alexandria, MN

Dayton-Granger, Inc., Ft. Lauderdale, FL

General Aircraft Maufacturers Association, Washington, D.C.

Ying Ling Aviation, Wichita, KS

The Institute for Aviation Research and Development, Wichita State University, Wichita, KS

Pro Flite Inc., Vero Beach, FL

Boca Aviation, Boca Raton, FL

Pompano Air Service, Pompano Beach, FL

Frederick Aviation, Frederick, MD

Aircraft Owners and Pilots Association, Frederick, MD

Minnesota Department of Transportation, St. Paul, MN

Classic Cessna, Eden Prarie, MN

Thunderbird Piper, Eden Prarie, MN

Experimental Aircraft Association, Washington, DC, Oskosh, WI

DeVore Aviation, Albuquerque, NM

Zenair, Nobelton, Ontario, Canada

Fisher Flying Products, South Webster, OH

National Association of Flight Instructors

Aeritalia, Arlington, VA Office

Aerospatiale-Socata, Washington, DC Office

AVEMCO Insurance Company, Frederick, MD

AVCO Lycoming, Williamsport, PA

John Deere Technology, Trenton, NJ

Grob Systems, Bluffton, OH

Rockwell International, Collins Avionics, Div. Cedar Rapids, IA

Flight Service Stations, Minneapolis, MN; Princeton, MN; Wichita, KS; Vero Beach, FL

APPENDIX B

SINGLE ENGINE FIXED GEAR

SINGLE-ENGINE FIXED GEAR

Manufacturer and Model	Seats	Powerplant/ Prop type	Fuel Capacity (lb/gal)	Gross Wgt/ Empty Wgt/ Max Payload (w/full fuel lb)	Cruise Speed (kt)/ Fuel Flow 75% @ alt/pph/gph 65% @ alt/pph/gph	Range w/45-min rsv (nm) 75% @ alt 65% @ alt	Takeoff/ Landing Distance (over 50' obst)	*Rate of Climb (fpm)	Max Oprg Altitude	Stall Speed (landing config, kt)	Base Price
TAYLORCRAFT F-21	2	Lyc. O-235-L2C, 112 hp/FP	144/24	1,750 990 616	107 @ 8,000/36/6 NA	400 NA	450 500	700	18,000	55	$28,595
Price includes dual controls, engine and fuel gauges, navigation lights, dual toe brakes, shoulder harnesses, airspeed, altimeter, compass, owner's and engine manuals and logbooks. Price does not include interior or exterior finish											
TAYLORCRAFT F-21B	2	Lyc. O-235-L2C, 112 hp/FP	240/42	1,750 1,010 500	107 @ 8,000/36/6 NA	700 NA	450 500	750	18,000	48	$30,799
Standard equipment including interior and exterior finish											
MAULE M-5-180C	4	Lyc. O-360-C1F, 180 hp/CS	138/23	2,300 1,325 735	137 @ 7,500/63/10.5 130 @ 7,500/52/8.6	450 @ 7,500 490 @ 7,500	600 600	900	15,000	34	$39,342
STOL aircraft. Price includes dual controls, engine gauges, gyro instrumentation and heated pitot											
ARCTIC S1B2 Arctic Tern	2	Lyc. O-320-A2B, 150 hp/FP	240/40	1,900 988 672	102 @ 3,500/48/8 96 @ 3,500/42/7	500 @ 3,000 493 @ 3,000	325 500	1,275	19,000	30	$40,306 (est)
Price includes dual controls, toe brakes, 82/44 McCauley prop, 50 degree flaps, 1-inch Maule tailwheel, 850 × 6 tires, cabin heat, windshield defroster, lexan windshield and 1,500 lb Cleveland wheels and brakes.											
MAULE M-5-235C Lunar Rocket	4	Lyc. O-540-J1A5D, 235 hp/CS	138/23	2,300 1,400 660	150 @ 7,500/87/14.5 142 @ 7,500/72/12	405 @ 7,500 450 @ 7,500	600 600	1,350	20,000	34	$42,448
STOL aircraft. Gross weight when float equipped is 2,530 lbs. Price includes dual controls, engine gauges, gyro instrumentation and heated pitot. Lyc. IO-540-W1A5D fuel-injected model available for $44,749.											
MAULE M-6-235 Lunar Rocket	4	Lyc. O-540-J1A5D, 235 hp/CS	156/26	1,500 1,050 30	150 @ 7,500/90/15 142 @ 7,500/72/12	405 @ 7,500 450 @ 7,500	600 600	1,350	20,000	22	$43,148
STOL aircraft. Price includes dual controls, engine gauges, gyro instrumentation and heated pitot. Fuel-injected model available for $46,092.											
MAULE MX-7-235	4-5	Lyc. O-540-W1A5D 235 hp/CS	180/30	2,500 1,500 580	150 @ 7,500/90/15 142 @ 7,500/72/12	405 @ 7,500 450 @ 7,500	600 600	1,350	20,000	35	$44,695
STOL aircraft. Price includes dual controls and engine gauges. Fuel-injected model available for $46,795.											
MAULE M-7-235 Lunar Super Rocket	5	Lyc. O-540-J1A5D, 235 hp/CS	180/30	1,500 1,050 30	150 @ 7,500/90/15 142 @ 7,500/72/12	405 @ 7,500 450 @ 7,500	600 600	1,350	20,000	22	$50,655
STOL aircraft. Price includes dual controls, engine gauges, gyro instrumentation and heated pitot. Fuel-injected model available for $52,843.											
CESSNA 172 P Skyhawk	4	Lyc. O-320-D2J, 160 hp/FP	258/43	2,407 1,438 729	120 @ 8,000/50/8.4 111 @ 8,000/44/7.3	440 @ 8,000 587 @ 6,000	1,625 1,280	700	13,000	46	$53,050
Price includes engine gauges, gyro instrumentation, pitot-static system, exterior paint and dual controls. Max payload calculated at max standard fuel.											
AEROSPATIALE TB-10 Tobago	4	Lyc. O-360A1AD 180 hp/CS	324/54	2,535 1,477 734	127 @ 6,000/66/11 117 @ 6,000/54/9	460 @ 6,000 500 @ 8,000	1,657	790	13,000	52	$58,700
* CHRISTEN S-1T Pitts Special	1	Lyc. AEIO-360-AIE, 200 hp/CS	120/20	1,150 850 180	156 @ 8,000/75/12.5 NA	280 @ 8,000 NA	600 1,200	2,600	24,000	54	$58,935
Price includes sliding canopy and fixed windscreen, all-attitude fuel and oil systems, basic engine, flight instruments and standard paint design											
* CHRISTEN S-2S Pitts Special	1	Lyc. AEIO-540-D4A5, 260 hp/CS	210/35	1,575 1,100 265	156 @ 8,000/87/14.5 NA	374 @ 8,000 NA	925 1,350	2,800	22,000	52	$69,995
Price includes sliding canopy, fixed windscreen, all-attitude fuel and oil systems, basic engine, flight instruments and standard paint design											
* CHRISTEN S-2B Pitts Special	2	Lyc. AEIO-540-D4A5, 260 hp/CS	174/29	1,700 1,175 351	160 @ 8,000/103/17.2 NA	288 @ 8,000 NA	925 1,350	2,800	22,000	52	$73,850
Price includes jettisonable canopy with fixed forward windscreen, all-attitude fuel and oil systems, basic engine, flight instruments in both cockpits and standard paint design											

**Gross Weight, sea level. FP—Fixed Pitch. CS—Constant Speed; NA—Not Available*

* AEROBATIC

Manufacturer and Model	Seats	Powerplant Prop Type	Fuel Capacity (gal)	Gross Wgt Empty Wgt Max Payload (w/full fuel lb)	Cruise Speed (kt) Fuel Flow 75% @ alt pph/gph 65% @ alt pph/gph	Range w/45-min rsv (nm) 75% @ alt 65% @ alt	Takeoff Landing Distance (over 50' obst)	*Rate of Climb (fpm)	Max Oper Altitude	Stall Speed (landing config. kt)	Base Price
• MUDRY CAP 10B	2	Lyc AEIO 360-B2F 180 hp/FP	246/41	1,830 1,200 384	135 @ SL/60/10 130 @ SL/57/9.5	440 @ SL NA	1,477 1,968	1,100	17,000	43	$80,000
Price includes dual controls, engine gauges, pitot-static system, wiring for avionics and complete equipment for inverted aerobatics (shoulder harnesses, G-meter, etc.). Gross weight, rate of climb, takeoff and landing distance shown for Utility category.											
CESSNA 182 R Skylane	4	Cont. O-470-U, 230 hp/CS	552/92	3,110 1,734 848	142 @ 8,000/77/12.8 133 @ 8,000/66/11	820 @ 8,000 1,025 @ 10,000	1,515 1,350	865	14,900	49	$80,950
Price includes engine gauges, dual controls, pitot-static system, cylinder head temperature gauge and exterior paint.											
CESSNA U206G Stationair 6	6	Cont. IO-520-F, 300 hp/CS	552/92	3,612 1,944 1,140	147 @ 6,500/96/16 135 @ 6,500/78/13	680 @ 6,500 760 @ 10,000	1,780 1,395	920	14,800	54	$111,400
Price includes engine gauges, pitot-static system, cylinder head temperature gauge and exterior paint.											
CESSNA TU206G Turbo Stationair 6	6	Cont. TSIO-520-M, 310 hp/CS	552/92	3,616 2,022 1,066	162 @ 20,000/102/17 150 @ 20,000/84/14	643 @ 22,000 697 @ 22,000	1,640 1,395	1,010	27,000	54	$124,650
Price includes engine gauges, pitot-static system, cylinder head temperature gauge, dual controls, oxygen system less masks, exterior paint.											

**Gross Weight, sea level. FP—Fixed Pitch. CS—Constant Speed. NA—Not Available*

• AEROBATIC

SINGLE-ENGINE RETRACTABLE GEAR

Manufacturer and Model	Seats	Powerplant Prop type	Fuel Capacity Standard/Optional (gal)	Gross Wt* Empty Wt Max Payload (w/full fuel) (lb)	Cruise Speed (kt) Fuel Flow 75% @ alt (pph/gph) 65% @ alt (pph/gph)	Range w/45 min rsv (nm) 75% @ alt 65% @ alt	Takeoff Landing Distance (over 50' obst)	Rate of Climb (fpm)	Max Oper Altitude	Stall Speed landing config (kt)	Base Price
AEROSPATIALE TB-20 Trinidad	4-5	Lyc. IO-540-C4D5D 250 hp/CS	516/89 —	2,955 1,701 738	164 @ 8,000/72.6/12.1 160 @ 8,000/63/10.5	885 @ 8,000 964 @ 12,000	1,571 1,740	1,260	20,000	64	$9[illegible],850
BELLANCA 17-30A Super Viking	4	Cont. IO-520-K, 300 hp/CS	408/68 —	3,325 2,185 732	174 @ 7,500/96/16 162 @ 7,500/84/14	621 @ 7,500 673 @ 7,500	1,420 1,340	1,210	20,000	60	$92,000
Price includes dual controls, engine gauges, three-blade propeller and pitot-static system.											
MOONEY M20J 201	4	Lyc. IO-360-A3B6D 200 hp/CS	384/64 —	2,740 1,671 685	168 @ 8,000/66/11 163 @ 11,500/60/10	830 @ 4,000 910 @ 6,000	1,770 1,988	1,030	18,800	55	$97,500
Price includes dual controls, engine gauges and pitot static system.											
MOONEY M20J 201 Lean Machine	4	Lyc. IO-360-A3B6D, 200 hp/CS	384/64 —	2,740 1,671 685	168 @ 8,000/66/11 163 @ 11,500/60/10	830 @ 4,000 910 @ 6,000	1,770 1,988	1,030	18,800	55	$98,900
Price includes King avionics package: KMA 24 audio panel, KX 155 navicom w/GS, KI 209 VOR/LOC/GS indicator, KX 155 navicom, KI 208 VOR/LOC indicator, KR 86 ADF, KT 76A transponder, mike, KAP 100 flight control system includes heading select, VOR/LOC capture and track, flight computer, lighted AH and DG.											
CESSNA R182 Skylane RG	4	Lyc. O-540-J3C5D, 235 hp/CS	522/92 —	3,112 1,782 802	156 @ 7,500/78/13 148 @ 7,500/72/12	845 @ 7,500 940 @ 11,000	1,570 1,320	1,140	14,300	50	$106,650
Price includes engine gauges, gyro instrumentation, pitot-static system, dual controls, cylinder head temperature gauge and exterior paint.											
CESSNA TR182 Turbo Skylane RG	4	Lyc. O-540-L3C5D, 235 hp/CS	552/92 —	3,112 1,827 757	173 @ 20,000/84/14 162 @ 20,000/72/12	845 @ 7,500 940 @ 11,000	1,570 1,320	1,040	20,000	50	$118,500
Price includes engine gauges, gyro instrumentation, pitot-static system, cylinder head temperature gauge, oxygen system less masks and exterior paint.											
MOONEY M20K 252	4	Cont. TSIO-360-MB1, 210 hp/CS	456/76 —	2,900 1,800 647	202 @ 28,000/76.2/12.7 185 @ 28,000/66/11	935 @ 28,000 1,040 @ 28,000	2,000 2,300	1,080	28,000	59	$118,750
Price includes dual controls, engine gauges and pitot-static system.											
* LAKE LA4/200 EP	4	Lyc. IO-360-A1B6, 200 hp/CS	324/54 540/90	2,690 1,670 696	127 @ 6,500/60/10 122 @ 6,500/54/9	590 @ 6,500 640 @ 6,500	1,450 900 (water) 1,575 1,100 (land)	980	12,500	38	$133,200
Price includes dual controls, engine gauges, full TSOed gyro panel, heated pitot, corrosion proofing, cargo door, paddle and bowline.											
CESSNA 210R Centurion	6	Cont. IO-520-L, 300 hp/CS	540/90 —	3,812 2,220 1,060	169 @ 6,500/97/16 159 @ 6,500/82/14	765 @ 6,500 862 @ 10,000	2,030 1,500	980	17,300	55	$143,350
Price includes engine gauges, pitot-static system, cylinder head temperature gauge, dual controls and exterior paint. Optional 120 gal. LR tanks available.											
* LAKE LA4/200 Turbo EP	4	Lyc. IO-360-A1B6, 200 hp/CS	324/54 540/90	2,690 1,698 668	143 @ 20,000/60/10 127 @ 14,500/54/9	665 @ 20,000 667 @ 14,500	1,450 900 (water) 1,575 1,100 (land)	980	20,000	38	$144,780
Price includes Rajay turbocharger, dual controls, engine gauges, full TSOed gyro panel, heated pitot, corrosion proofing, cargo door, paddle and bowline.											
CESSNA T210R Turbo Centurion	6	Cont. TSIO-520-CE, 325 hp/CS	540/90 —	4,118 2,320 1,336	201 @ 20,000/101/17 190 @ 20,000/96/16	720 @ 23,000 790 @ 23,000	2,110 1,600	1,150	25,000	55	$165,750
Price includes engine gauges, pitot-static system, cylinder head temperature gauge, dual controls, optional 120 gal. LR tanks and exterior paint.											

*Gross Weight, sea level. FP—Fixed Pitch. CS—Constant Speed. NA—Not Available.

* AMPHIBIAN

Manufacturer Model	Seats	Powerplant Prop Type	Fuel Capacity Standard Optional (gal)	Gross Wgt. Empty Wgt. Max Payload w/full fuel (lb)	Cruise Speed (kt) Fuel Flow 75% @ alt gph/pph 65% @ alt gph/pph	Range w/45 min rsv (nm) 75% @ alt 65% @ alt	Takeoff Landing Distance over 50 ft (ft)	Rate of Climb (fpm)	Max Optg Altitude	Min Speed Landing Config (kt)	Base Price
• LAKE LA-250 Renegade	6	Lyc. IO-540-C4B5 250 hp/CS	324/54 540/90	3,050 1,950 776	132 @ 6,500/75/12.5 125 @ 6,500/66/11	851 @ 6,500 929 @ 6,500	1,250 NA (water) 1,590 1,150 (land)	900	12,500	48	$194,200
Price includes dual controls, engine gauges, gyro instruments, pitot static system, ELT, paddle, bowline and cargo door											
AGUSTA SIAI MARCHETTI SF 260C	3-4	Lyc. O-540-260 260 hp/CS	390/65 —	2,430 1,700 340	181 @ 5,000/93.5/15.5 176 @ 10,000/77/12.8	635 @ 6,000 755 @ 10,000	1,550 1,450	1,800	19,000	60	$195,000
Price includes full IFR equipment, including HSI. Certified in aerobatic category with full inverted fuel and oil systems.											
BEECH A36 Bonanza	4-6	Cont. IO-550-B 300 hp/CS	444/74 —	3,650 2,247 972	176 @ 6,000/102/17 167 @ 8,000/86/14	756 @ 6,000 876 @ 12,000	1,913 1,473	1,210	18,500	59	$198,560 (est)
Price includes engine gauges, navicom and pitot-static system. Max payload calculated at max standard fuel.											
BEECH B36TC Bonanza	6	Cont. TSIO-520-UB 300 hp/CS	612/102 —	3,850 2,353 891	195 @ 25,000/96/16 188 @ 25,000/86/14 (69%)	984 @ 25,000 1,022 @ 25,000 (69%)	2,141 1,692	1,049	25,000	57	$223,708 (est)
Price includes engine gauges, navicom, VORILOC, turbocharged engine, individual toe brakes, gyro instrumentation, clock, fuel gauges, logbooks and manuals, polyurethane exterior paint and ELT.											
CESSNA P210R Pressurized Centurion	6	Cont. TSIO-520-CE, 325 hp/CS	540/90 —	4,118 2,471 1,115	201 @ 20,000/101/17 190 @ 20,000/96/16	720 @ 23,000 790 @ 23,000	2,110 1,600	1,150	25,000	55	$235,200
Price includes engine gauges, pitot-static system, cylinder head temperature gauge, dual controls, all metal instrument panel, optional 120 gal. LR tanks, pressurization system and exterior paint.											
PIPER PA-46-310P Malibu	6	Cont. TSIO-520-BE, 310 hp/CS	732/122 —	4,100 2,465 932	215 @ 25,000/96/16 205 @ 25,000/84/14	1,330 @ 25,000 1,420 @ 25,000	2,025 1,800	1,143	25,000	59	$330,000
Price includes full IFR equipment and ELT.											

• AMPHIBIAN

ON HOLD

SINGLE - ENGINE FIXED GEAR

Manufacturer and Model	Seats	Powerplant/ Prop type	Fuel Capacity (lb/gal)	Gross Wgt/ Empty Wgt/ Max Payload (w/full fuel lb)	Cruise Speed (kt)/ Fuel Flow 75% @ alt/pph/gph 65% @ alt/pph/gph	Range w/45-min rsv (nm) 75% @ alt 65% @ alt	Takeoff/ Landing Distance (over 50 obst)	Rate of Climb (fpm)	Max Op'g Altitude (ft)	Stall Speed (landing config, kt)
CESSNA 152	2	Lyc. O-235-N2C 108 hp/FP	156/26	1,675 1,104 424	105 @ 8,500/36/6 99 @ 8,000/31/5.2	315 @ 8,500 342 @ 11,000	1,340 1,200	715	14,700	43
CESSNA 152 Aerobat	2	Lyc. O-235-N2C 108 hp/FP	156/26	1,675 1,131 397	105 @ 8,500/36/6 97 @ 8,000/31/5.2	310 @ 8,500 338 @ 11,000	1,340 1,200	715	14,700	43
CESSNA 172Q Cutlass	4	Lyc. O-360-A4N 180 hp/FP	324/54	2,558 1,480 778	122 @ 8,500/60/10 112 @ 6,000/53/8.8	475 @ 8,500 510 @ 6,000	1,690 1,335	680	17,000	48
CESSNA T182 Turbo Skylane	4	Lyc. TO-540-L3C5D 235 hp/CS	552/92	3,112 1,752 832	158 @ 20,000/90/15 147 @ 20,000/78/13	745 @ 20,000 812 @ 20,000	1,475 1,350	965	20,000	49
CESSNA A185F Skywagon	6	Cont. IO-520-D, 300 hp/CS	528/88	3,362 1,727 1,199	147 @ 7,000/95/16 138 @ 7,000/78/13	645 @ 7,000 715 @ 10,000	1,430 1,400	1,075	17,900	49
CESSNA 207A Stationair 8	8	Cont. IO-520-F 300 hp/CS	366/61	3,812 2,136 1,352	143 @ 6,500/95/16 133 @ 6,500/84/14	350 @ 6,500 393 @ 6,500	1,970 1,500	810	13,000	58
CESSNA T207A Turbo Stationair 8	8	Cont. TSIO-520-M 310 hp/CS	366/61	3,816 2,193 1,299	157 @ 20,000/96/16 145 @ 20,000/84/14	340 @ 12,000 355 @ 8,000	1,860 1,500	885	26,000	58
PIPER PA-28-181 Archer II	4	Lyc. O-360-A4M 180 hp/FP	300/50	2,550 1,413 849	129 @ 8,000/63/10.5 125 @ 12,000/54/9	500 @ 8,000 645 @ 12,000	1,660 1,390	735	13,650	47
PIPER PA-28-236 Dakota	4	Lyc. O-540-J3A5D 235 hp/CS	462/77	3,000 1,610 958	144 @ 9,100/81.6/13.6 138 @ 12,200/70.8/11.8	720 @ 8,500 770 @ 11,400	1,216 1,530	1,110	17,500	65
PIPER PA-32-301 Saratoga	6-7	Lyc. IO-540-K1G5, 300 hp/CS	642/107	3,600 1,935 1,068	150 @ 6,000/108/18 146 @ 10,000/96/16	823 @ 8,000 911 @ 10,000	1,573 1,530	990	16,000	58
PIPER PA-28-161 Warrior II	4	Lyc. O-320-D3G, 160 hp/FP	300/50	2,440 1,348 811	126 @ 9,000/60/10 118 @ 12,500/52/8.6	590 @ 9,000 633 @ 12,500	1,650 1,160	644	11,000	44

SINGLE - ENGINE RETRACTABLE GEAR

Manufacturer and Model	Seats	Powerplant/ Prop type	Fuel Capacity Standard Optional (lb/gal)	Gross Wgt/ Empty Wgt/ Max Payload (w/full fuel lb)	Cruise Speed (kt)/ Fuel Flow 75% @ alt/pph/gph 65% @ alt/pph/gph	Range w/45-min rsv (nm) 75% @ alt 65% @ alt	Takeoff/ Landing Distance (over 50 obst)	Rate of Climb (fpm)	Max Op'g Altitude	Stall Speed (landing config, kt)
BEECH F33A Bonanza	4-5	Cont. IO-520-BB 285 hp/CS	444/74 --	3,400 2,125 843	172 @ 6,000/90/15 163 @ 8,000/78/13	716 @ 6,000 777 @ 10,000	1,769 1,324	1,167	17,858	51
PIPER PA-32R-301 Saratoga SP	6-7	Lyc. IO-540-K1G5D 300 hp/CS	642/107 —	3,600 1,999 1,004	159 @ 6,200/108/18 153 @ 10,400/96/16	865 @ 6,400 937 @ 10,400	1,573 1,530	1,010	16,700	57
PIPER PA-28RT-201T Turbo Arrow IV	4	Cont. TSIO-360-FB 200 hp/CS	462/77 —	2,900 1,692 776	172 @ 18,500/84/14 167 @ 20,000/78/13	790 @ 18,000 830 @ 18,000	1,620 1,560	940	20,000	61
PIPER PA-32R-301T Turbo Saratoga SP	6-7	Lyc. TIO-540-S1AD 300 hp/CS	642/107 —	3,600 2,078 927	177 @ 20,000/119.4/19.9 166 @ 20,000/103.2/17.2	844 @ 20,000 920 @ 20,000	1,420 1,640	1,120	20,000	56

IN THE WORKS

SINGLE-ENGINE PISTON

Manufacturer and Model	Seats	Powerplant hp/prop type	Fuel Capacity (lb/gal)	Gross Wgt / Empty Wgt / Max Payload (w/full fuel) (lb)	Cruise Speed (kt)/Fuel Flow 75% @ alt/pph/gph 65% @ alt/pph/gph	Range w/45-min rsv (nm) 75% @ alt 65% @ alt	Takeoff/Landing Distance over 50 ft	Rate of Climb (fpm)	Max Cert Altitude (ft)	Stall Speed landing config (kt)	Target Base Price
DEVORE AVIATION V-100 Sunbird	2	Embar OF 077A 60 hp fp	72/12	1,050 565 413	100 @ NA/18/3 NA	325 @ NA NA	1,000 525	755	NA	35	**$22,000**
Certification expected mid 1987. Price (in 1985 dollars) includes VFR day/night airplane with nav/com, VSI, turn coordinator and dual controls.											
GROB G115	2	Lyc O-245 116 hp FP	148/26	1,984 1,400 584	123 @ 5,000/43/7 125 @ 8,000/38/6	363 @ 5,000 422 @ 8,000	1,480 1,600	760	18,000	50	**$36,000**
Certification expected in 1986.											
AEROSPATIALE TB 20 Trinidad TC	4	Lyc TIO-540-AB1AD 250 hp CS	444/74	3,038 1,795 857	187 @ 25,000/98.4/16.4 170 @ 25,000/74.4/12.4	890 @ 25,000* 1,030 @ 25,000*	NA NA	1,090**	25,000	59	**$107,800**
*No Reserve. **At 2,000 ft. Certification expected first quarter 1986.											

Gross weight, sea level. OGE—Out of Ground Effect. IGE—In Ground Effect. NA—Not Available.

SOURCE: AOPA PILOT - MARCH 1986

NEW SINGLE-ENGINE PISTON AIRCRAFT

AVERAGE RETAIL PRICE - 1985

Gross Weight (Pounds)	Average Price
1,675 to 1,900	$ 52,200
2,300 to 2,550	83,800
2,690 to 2,955	89,800
3,000 to 3,362	118,600
3,400 to 3,850	174,000
4,100	330,000
Turbocharged 3,112 to 4,118	139,400
Pressurized 4,116	235,200

Average based on prices in **AOPA Pilot**, March 1966.

APPENDIX C

AVERAGE RETAIL PRICES OF SELECTED SEP AIRCRAFT

AVERAGE RETAIL PRICES OF SELECTED SEP AIRCRAFT

BEECH (BONANZA 36)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	54,500	55,000	53,000	52,500	52,500	53,800	55,000	55,500	45,375
73-77	73,000	73,750	72,500	69,250	75,000	72,000	77,125	72,000	69,300
78	87,500	90,000	95,000	88,000	92,500	93,500	102,500	90,500	90,500
79	98,000	102,500	107,500	96,500	121,000	121,500	98,310	102,550	
80	107,500	115,000	115,000	112,000	135,000				
81	122,500	125,000	125,000	128,000					
82	136,000	137,500	137,500	185,000					
83	150,000	157,500	201,410						
84	185,000	217,900							

BEECH (BONANZA 33)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	42,500	42,250	44,750	42,500	44,000	44,500	45,875	36,500	35,500
73-77	60,500	64,500	64,000	59,250	64,750	65,500	68,500	64,000	67,500
78	80,000	80,000	80,000	73,500	80,300	81,000	92,000	93,000	
79	86,000	86,000	87,500	83,000	83,500	84,000	98,225		
80	94,000	92,500	95,000	115,000	109,000	110,750			
81	108,500	107,500	110,000	126,000	126,000				
82	120,000	127,500	135,000	139,000					
83	131,000	147,500	175,000						
84	146,000	180,000							

BEECH (SKIPPER)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
79	11,500	12,000	11,000	15,000					
80	12,700	13,000	12,000	16,500	17,000				
81	14,500	15,500	14,500	24,250	20,500				

BELLANCA (SUPER VIKING)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	20,000	21,750	20,500	19,500	19,500	22,500	24,750	25,000	25,250
73-77	32,000	34,250	34,250	37,500	37,500	41,025	45,625	44,375	49,312
78	45,000	46,500	46,500	52,500	52,500	64,500	66,000	68,000	
79	52,000	53,800	50,500	55,000	55,000	75,750	78,000		
80	58,500	62,500	60,000	58,000	58,000				
81	NONE	58,500							
82	NONE	58,500							
83	NONE	58,500							
84	95,000	125,000							

CESSNA (210)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	30,000	31,500	32,750	33,000	30,250	34,750	36,375	36,625	34,500
73-78	46,000	45,000	45,000	45,000	52,760	60,250	63,275	52,500	51,875
79	59,000	58,000	58,000	62,000	70,000	95,000	97,000		
80	65,000	69,500	78,500	72,000	83,500				
81	77,000	77,500	80,000	93,000	125,000				
82	98,500	105,000	110,000	138,000					
83	120,000	127,500							
84	140,000	169,965							

CESSNA (172 SKY HAWK)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	13,200	13,500	12,625	12,500	13,000	13,000	13,500	13,750	13,750
73-78	17,000	17,250	16,500	16,000	21,000	21,000	23,800	28,500	
79	22,000	19,500	20,000	33,000	29,500	29,500	35,000		
80	24,000	23,250	23,500	35,000	40,000				
81	30,000	29,500	30,000	40,000					
82	33,000	35,000	37,000	55,000					
83	39,500	45,000	60,285						
84	49,000	64,940							

CESSNA (182 SKYLANE)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	22,000	20,750	20,750	19,500	19,500	19,500	21,000	21,250	28,500
73-78	30,000	29,500	29,250	32,125	32,125	30,625	33,250	36,000	
79	38,500	38,500	38,000	45,000	45,000	40,000	45,000		
80	43,000	42,500	43,000	49,500	53,500	55,500			
81	47,000	48,000	48,000	65,800	65,800				
82	53,000	56,000	60,000	69,000					
83	63,000	70,000	87,000						
84	71,500	93,625							

CESSNA (185 SKYWAGON)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	31,000	24,000	24,000	20,500	19,000	21,500	23,750	24,250	23,125
73-78	40,000	35,000	34,000	30,500	32,000	36,375	41,000	41,400	34,125
79	48,500	48,000	47,000	42,250	45,000	50,000	56,500		
80	57,000	54,000	53,000	50,000	55,000				
81	65,000	60,000	60,000	60,000	67,500				
82	67,000	68,000	68,000	80,000					
83	76,000	80,000	94,000						
84	87,500	100,500							

CESSNA (180-H SKYWAGON)

Model Year	86	85	84	83	82	81	80	79	78
68-72	24,500	28,750	24,750	23,625	19,000	20,400	21,250	21,750	20,250
73-78	30,000	38,825	31,750	30,000	27,375	30,250	34,500	35,000	33,562
79	36,000	46,750	38,000	38,000	40,500	45,000	54,500		
80	39,000	51,000	42,000	44,000	49,500				
81	41,500	65,000	46,000	50,000	60,000				

CESSNA (STATIONAIR)

Model Year	86	85	84	83	82	81	80	79	78
78	45,000	44,000	44,000	45,000	48,500	60,000	63,500	63,750	
79	48,500	46,750	47,500	47,800	50,500	65,000	67,500		
80	57,000	51,500	52,500	62,500	62,500				
81	65,000	65,000	67,500	75,000	75,000				
82	78,500	83,000	90,000	95,000					
83	97,500	105,000							
84	110,000	138,065							

MOONEY (MARK 201)

Model Year	86	85	84	83	82	81	80	79	78
77	44,000	42,750	43,500	45,000	45,000				
78	48,000	47,000	48,000	50,000	50,000				
79	52,000	52,000	52,000	55,000	55,000				
80	56,000	58,000	59,000	65,000	65,000				
81	61,000	63,500	69,000	75,000	85,500				
82	70,000	72,500	79,000	10,200					
83	80,000	83,000							
84	92,500	123,795							

MOONEY (MARK 21 RANGER)

Model Year	86	85	84	83	82	81	80	79	78
67-72	23,500	23,250	22,000	20,750	19,125	15,275	21,125	18,750	18,750
73-78	28,500	28,625	28,500	27,500	29,250	26,375	35,625	35,875	31,750
79	31,500			35,000	35,000	34,500	45,500		

PIPER (SUPER CUB)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
68-72	19,000	17,625	16,250	14,500	15,500	11,500	13,500	13,750	13,750
73-78	23,500	22,500	25,250	20,750	21,875	18,625	20,750	20,625	20,500
79	29,500	27,500	28,000	25,250	26,000	26,000	28,000		
80	31,000	30,000	30,000	26,500	30,000				
81	33,000	32,000	32,000	29,000	35,000				
82	35,000	35,000	36,000						
83	38,700								

PIPER (COMANCHE PA-24-250)

Model Year	Year Sold 86	85	84	83	82	81	80	79	78
67-72	34,000	34,250	34,750	36,875		36,000	38,250	36,500	36,500

Source: Aircraft Bluebook Price Digest, 1978-1986.

APPENDIX D

SINGLE ENGINE PISTON STUDY

DATABASE AND CORRELATION MATRIX

DATABASE

Year	Single Engine Piston Shipments[1]	Value of Single Engine Piston Shipments[1] (000,000's)	Unit Value of Single Engine Piston Shipments[2]	Multi-Engine Piston Shipments[3]	Turbo-Prop Piston Shipments[3]
1970	5,603			1,159	135
1971	5,910			1,043	89
1972	7,438	139	18,723	1,548	179
1973	10,140	202	19,916	2,413	247
1974	10,884	229	21,069	2,135	250
1975	10,532	254	24,117	2,116	305
1976	11,803	364	30,840	2,120	359
1977	13,167	435	33,037	2,195	428
1978	13,651	486	35,602	2,634	548
1979	12,693	490	38,604	2,843	639
1980	8,283	365	44,066	2,116	778
1981	6,268	315	50,255	1,542	918
1982	2,697	183	67,853	678	458
1983	1,739	137	78,781	417	321
1984	1,592	145	91,080	374	272
1985	1,369	124	90,511	193	321
1986	985	80	81,218	138	250

[1] Aerospace Facts and Figures 1985-1986.

[2] Derived by decoding value of shipments by units shipped.

[3] GAMA, General Aviation Statistical Handbook, 1985 Edition.

DATABASE (CONTINUED)

Year	Jet Engine Shipments[1]	Total Units Shipped[1]	Total Billings[1]	Average Price[2]	Student Pilots[1]	General Aviation Hours Flown[3]
1970	56	7,292	33,700	46,215		
1971	47	7,466	32,150	43,062		
1972	134	9,774	55,760	57,049	121,543	26.4
1973	198	13,646	82,810	60,684	131,384	28.5
1974	202	14,166	90,940	64,196	113,997	30.7
1975	194	14,056	103,290	73,485	127,424	31.7
1976	187	15,451	122,550	79,315	129,280	33.0
1977	227	16,904	148,810	88,032	138,816	35.3
1978	231	17,811	178,120	100,006	137,032	37.1
1979	282	17,048	216,500	126,994	139,956	39.0
1980	326	11,877	248,620	209,329	102,301	41.6
1981	389	9,457	291,990	308,755	117,962	41.1
1982	259	4,266	199,950	468,706	84,761	37.8
1983	142	2,691	146,950	546,080	94,981	36.4
1984	171	2,438	169,810	696,514	91,395	35.9
1985	145	2,029	143,000	704,781	80,060	36.6
1986	122	1,495	126,000	842,809	88,582	

[1]GAMA, General Aviation Statistical Handbook, 1985 Edition.

[2]Derived by decoding value of shipments by units shipped.

[3]Federal Aviation Administration, Aviation Forecasts: 1986-1997, 1980-1991 & 1975-1986.

DATABASE (CONTINUED)

Year	Itinerant General Aviation Operations[1]	Local General Aviation Operations[1]	Total General Aviation Operations[1]	Housing Cost Index[2]	Insurance Cost Index[2]	Annual Disposable Income[2]
1970						695,300
1971						764,977
1972	33.6	20.1	53.7	128.1	140.5	834,654
1973	34.0	19.9	53.9	133.7	138.0	943,635
1974	36.1	20.8	56.9	148.8	138.1	1,032,853
1975	37.6	21.4	59.0	164.5	145.9	1,137,411
1976	39.7	22.8	62.5	174.6	187.9	1,247,873
1977	42.4	24.3	66.7	186.5	210.5	1,374,288
1978	43.6	23.6	67.2	202.8	216.6	1,545,709
1979	45.9	24.7	70.6	227.6	228.7	1,722,740
1980	44.3	21.9	66.2	263.3	247.4	1,912,276
1981	42.0	19.5	61.5	293.5	259.0	2,119,926
1982	36.0	14.7	50.7	314.7	275.7	2,252,631
1983	38.0	15.3	53.3	323.1	302.7	2,423,679
1984	41.0	15.8	56.8	336.5	326.3	2,662,815
1985	41.9	16.0	57.9	349.9	359.5	2,825,215
1986				361.5	334.6	

[1]Federal Aviation Administration, Aviation Forecasts: 1986-1997, 1980-1991 & 1975-1986.

[2]Department of Labor, Bureau of Labor Statistics, Components of Consumer Price Index.

DATABASE (CONTINUED)

Year	Annual Per Capita Income[1]	Aviation Gasoline Price[2]	Gross National Product[3]	Gross National Product Deflator[3]	Consumer Price Index 1967=100	Treasury Bill Interest Rate[4]
1970	3,390	19.24	992.7	91.5	116.3	6.46
1971	3,689	20.53	1,077.6	96.0	121.3	4.34
1972	3,988	20.72	1,185.9	100.0	125.3	4.07
1973	4,465	23.78	1,326.4	105.8	133.1	7.04
1974	4,841	37.53	1,434.2	115.1	147.7	7.89
1975	5,279	41.13	1,549.2	125.8	161.2	5.84
1976	5,736	43.12	1,718.0	132.3	170.5	4.99
1977	6,254	47.52	1,918.3	140.1	181.5	5.27
1978	6,960	51.95	2,163.9	150.4	195.4	7.22
1979	7,671	68.64	2,417.8	163.4	217.4	10.04
1980	8,415	109.03	2,631.7	178.4	246.8	11.51
1981	9,232	131.42	2,957.8	195.6	272.4	14.08
1982	9,710	132.53	3,069.3	207.4	289.1	10.69
1983	10,345	124.58	3,304.8	215.3	298.4	8.62
1984	11,259	123.33	3,662.8	223.4	311.1	9.58
1985	11,834	120.15	3,998.1	232.9	322.2	7.49
1986		111.95	4,206.5	237.4	326.9	

[1] Department of Labor, Bureau of Labor Statistics, Components of Consumer Price Index. (All urban consumers U.S. city average 1967=100.)

[2] U.S. Department of Energy, Energy Information Administration, Monthly Energy Review

[4] U.S. Department of the Treasury

[3] Statistical Abstract

DATABASE (CONTINUED)

Year	Prime Interest Rate[1]	Personal Consumption Expenditures[2]	Maintenance[2] and Overhaul Costs	Hourly[2] Fuel Costs	Total[2] Operating Costs
1970	7.91	618.8	1.40	4.35	5.75
1971	5.72	672.2	1.51	4.33	5.84
1972	5.25	737.1	1.62	4.43	6.05
1973	8.03	812.0	1.97	4.87	6.84
1974	10.81	888.1	2.10	6.59	8.69
1975	7.86	976.4	2.25	7.04	9.29
1976	6.84	1,084.3	2.74	7.67	10.41
1977	6.82	1,204.4	2.99	8.96	11.95
1978	9.06	1,403.5	3.11	10.23	13.34
1979	12.67	1,568.8	3.26	12.24	15.50
1980	15.26	1,732.6	3.48	16.15	19.63
1981	18.87	1,915.1	3.68	18.86	22.54
1982	14.86	2,050.7	4.10	19.66	23.76
1983	10.79	2,334.5	4.36	19.96	24.32
1984	12.04	2,428.2	4.53	19.76	24.29
1985	10.48	2,600.5	4.57	19.36	23.93
1986		2,760.0	4.62	18.25	22.87

[1] Statistical Abstract.

[2] Office of Aviation Policy, Federal Aviation Administration.

DATABASE (CONTINUED)

Year	Flight Plans Filed at Flight Service Stations[1]	Pilot Briefings at Flight Service Stations[1]	Aircraft Contacts at Flight Service Stations[1]
1972	6.6	13.5	10.0
1973	7.2	14.7	9.9
1974	7.8	15.4	9.9
1975	8.0	16.2	10.0
1976	8.1	16.0	9.8
1977	8.7	16.9	10.2
1978	9.1	18.3	10.2
1979	9.5	18.7	10.2
1980	9.0	18.3	9.6
1981	8.8	17.7	9.6
1982	8.5	17.8	9.7
1983	8.1	16.0	8.6
1984	8.2	15.1	8.1
1985	8.0	14.6	7.7

[1] Federal Aviation Administration, Aviation Forecasts: 1986-1997, 1980-1991 and 1975-1986.

CORRELATION MATRIX

Correlations:	SEP	SEPS	UNITS	MULT	TURBO	JET
SEP	1.0000	.7962**	-.8486**	.9634**	.1398	.2257
SEPS	.7962**	1.0000	-.4301	.7816**	.5927	.5544
UNITS	-.8486**	-.4301	1.0000	-.8594**	.0498	-.1208
MULT	.9634**	.7816**	-.8594**	1.0000	.2563	.3595
TURBO	.1398	.5927	.0498	.2563	1.0000	.9361**
JET	.2257	.5544	-.1208	.3595	.9361**	1.0000
TOTUNITS	.9977**	.8125**	-.8501**	.9759**	.1959	.2846
BILLINGS	-.1438	.4187	.3794	-.0382	.9302**	.8467**
AVGPRICE	-.9101**	-.5609	.9865**	-.9130**	-.0349	-.1767
STUDENTS	.9251**	.7182*	-.8159**	.8992**	.1130	.1810
HOURS	-.2021	.4015	.5225	-.1369	.8347**	.6894*
FTINOPS	.1960	.6895*	.2675	.1980	.6885*	.5000
LOCOPS	.9546**	.8633**	-.7536**	.9275**	.2850	.3063
TOTOPS	.6527*	.9173**	-.2466	.6408*	.6000	.4925
HOUSINDX	-.7945**	-.2857	.9585**	-.7668**	.3152	.1477
INSINDX	-.7390*	-.2288	.9661**	-.7451*	.2516	.0439
DISPINC	-.7779**	-.2775	.9727**	-.7611**	.2710	.0909
PCINC	-.7666**	-.2576	.9680**	-.7484*	.2906	.1103
AVGAS	-.7747**	-.2638	.8752**	-.7132*	.4462	.3202
GNP	-.7713**	-.2719	.9699**	-.7554**	.2736	.0900
GNPDFLTR	-.7724**	-.2581	.9615**	-.7530**	.3099	.1346
TBILL	-.3651	.0663	.4292	-.1950	.7594**	.7649**
PRIME	-.3854	.0466	.4380	-.2316	.7603**	.7676**
MOCOSTS	-.7017*	-.1682	.9528**	-.7036*	.3043	.1196
FUELHR	-.7700**	-.2441	.9144**	-.7228*	.4067	.2560
TOT	-.7641**	-.2347	.9239**	-.7235*	.3944	.2383
FPLANS	.2210	.7332*	.2159	.2465	.7747**	.6735*
PBRIEFS	.3218	.7549**	-.0070	.3875	.8210**	.7787**
ACCONT	.8448**	.6373*	-.8846**	.8630**	.2096	.3699

N of cases: 14 1-tailed Signif: * - .01 ** - .001

CORRELATION MATRIX (CONTINUED)

Correlations:	TOTUNITS	BILLINGS	AVGPRICE	STUDENTS	HOURS	ITINOPS
SFP	.9977**	-.1438	-.9101**	.9251**	-.2021	.1960
SFPS	.8125**	.4187	-.5609	.7182*	.4015	.6895*
UNITS	-.8501**	.3794	.9865**	-.8159**	.5225	.2675
MULT	.9759**	-.0382	-.9130**	.8992**	-.1369	.1980
TURBO	.1959	.9302**	-.0349	.1130	.8347**	.6885*
JET	.2846	.8467**	-.1767	.1810	.6894*	.5000
TOTUNITS	1.0000	-.0923	-.9129**	.9237**	-.1620	.2156
BILLINGS	-.0923	1.0000	.2941	-.1614	.9490**	.7130*
AVGPRICE	-.9129**	.2941	1.0000	-.8678**	.4185	.1392
STUDENTS	.9237**	-.1614	-.8678**	1.0000	-.2716	.1291
HOURS	-.1620	.9490**	.4185	-.2716	1.0000	.7972**
ITINOPS	.2156	.7130*	.1392	.1291	.7972**	1.0000
LOCOPS	.9578**	.0073	-.8328**	.8915**	-.0420	.4035
TUTOPS	.6671*	.4618	-.3717	.5758	.4875	.8627**
HOUSINDX	-.7791**	.6087	.9285**	-.7804**	.7181*	.3932
INSINDX	-.7336*	.5406	.9243**	-.7234*	.6817*	.4694
DISPINC	-.7671**	.5689	.9414**	-.7642**	.6943*	.4254
PCINC	-.7547**	.5864	.9338**	-.7544**	.7106*	.4404
AVGAS	-.7468*	.7087*	.8506**	-.7675**	.7674**	.3500
GNP	-.7609**	.5668	.9394**	-.7568**	.6919*	.4365
GNPDFLTR	-.7587**	.6042	.9263**	-.7604**	.7241*	.4225
TBILL	-.3100	.8723**	.4060	-.3741	.7843**	.3996
PRIME	-.3314	.8725**	.4182	-.4230	.7929**	.3883
MOCOSTS	-.6921*	.6027	.8987**	-.6990*	.7429*	.4808
FUELHR	-.7475*	.6845*	.8808**	-.7567**	.7679**	.3929
TOT	-.7433*	.6763*	.8873**	-.7522**	.7680**	.4069
FPLANS	.2507	.8184**	.0788	.1224	.8775**	.8741**
PBRIEFS	.3618	.7931**	-.1338	.2202	.7908**	.6835*
ACCONT	.8571**	-.0658	-.9206**	.8111**	-.2120	-.0777

N of cases: 14 1-tailed Signif: * - .01 ** - .001

CORRELATION MATRIX (CONTINUED)

Correlations:	LOCOPS	TOTOPS	HOUSINDX	INSINDX	DISPINC	PCINC
SEP	.9546**	.6527*	-.7945**	-.7390*	-.7779**	-.7666**
SEPS	.8633**	.9173**	-.2857	-.2288	-.2775	-.2576
UNIT$	-.7536**	-.2466	.9585**	.9661**	.9727**	.9680**
MULT	.9275**	.6408*	-.7668**	-.7451*	-.7611**	-.7484*
TURBO	.2850	.6000	.3152	.2516	.2710	.2906
JET	.3063	.4925	.1477	.0439	.0909	.1103
TOTUNITS	.9578**	.6671*	-.7791**	-.7336*	-.7671**	-.7547**
BILLINGS	.0073	.4618	.6087	.5406	.5689	.5864
AVGPRICE	-.8328**	-.3717	.9285**	.9243**	.9414**	.9338**
STUDENTS	.8915**	.5758	-.7804**	-.7234*	-.7642**	-.7544**
HOURS	-.0420	.4875	.7181*	.6817*	.6943*	.7106*
ITINOPS	.4035	.8627**	.3932	.4694	.4254	.4404
LOCOPS	1.0000	.8105**	-.6747*	-.5985	-.6536*	-.6409*
TOTOPS	.8105**	1.0000	-.1216	-.0316	-.0893	-.0728
HOUSINDX	-.6747*	-.1216	1.0000	.9726**	.9934**	.9942**
INSINDX	-.5985	-.0316	.9726**	1.0000	.9877**	.9870**
DISPINC	-.6536*	-.0893	.9934**	.9877**	1.0000	.9997**
PCINC	-.6409*	-.0728	.9942**	.9870**	.9997**	1.0000
AVGAS	-.6610*	-.1412	.9694**	.8966**	.9380**	.9416**
GNP	-.6432*	-.0764	.9898**	.9897**	.9992**	.9986**
GNPDFLTR	-.6516*	-.0903	.9985**	.9794**	.9965**	.9975**
TBILL	-.2825	.1041	.6327*	.4988	.5829	.5948
PRIME	-.3016	.0854	.6483*	.5096	.5939	.6055
MOCOSTS	-.5851	-.0173	.9804**	.9814**	.9845**	.9869**
FUELHR	-.6525*	-.1089	.9888**	.9371**	.9681**	.9713**
TOT	-.6462*	-.0967	.9922**	.9476**	.9748**	.9779**
FPLANS	.3359	.7459*	.3982	.3923	.3916	.4121
PBRIEFS	.3842	.6516*	.2207	.1632	.1814	.2043
ACCONT	.7565**	.3708	-.7722**	-.8077**	-.8106**	-.7978**

N of cases: 14 1-tailed Signif: * - .01 ** - .001

CORRELATION MATRIX (CONTINUED)

Correlations:	AVGAS	GNP	GNPDEFLTR	TBILL	PRIME	MOCOSTS
[illegible]	-.7747**	-.7713**	-.7724**	-.3651	-.3854	-.7017*
[illegible]	-.2638	-.2719	-.2581	.0663	.0466	-.1682
[illegible]	.8752**	.9699**	.9615**	.4292	.4380	.9528**
[illegible]	-.7132*	-.7554**	-.7530**	-.1950	-.2316	-.7036*
[illegible]	.4462	.2736	.3099	.7594**	.7603**	.3043
[illegible]	.3202	.0900	.1346	.7649**	.7676**	.1196
[illegible]	-.7468*	-.7609**	-.7587**	-.3100	-.3314	-.6921*
[illegible]	.7087*	.5668	.6042	.8723**	.8725**	.6027
[illegible]	.8506**	.9394**	.9263**	.4060	.4182	.8987**
[illegible]	-.7675**	-.7568**	-.7604**	-.3741	-.4230	-.6990*
[illegible]	.7674**	.6919*	.7241*	.7843**	.7929**	.7429*
[illegible]	.3500	.4365	.4225	.3996	.3883	.4808
[illegible]	-.6610*	-.6432*	-.6516*	-.2825	-.3016	-.5851
[illegible]	-.1412	-.0764	-.0903	.1041	.0854	-.0173
[illegible]	.9694**	.9898**	.9985**	.6327*	.6483*	.9804**
[illegible]	.8966**	.9897**	.9744**	.4988	.5096	.9814**
[illegible]	.9380**	.9992**	.9965**	.5829	.5939	.9845**
[illegible]	.9416**	.9986**	.9975**	.5948	.6055	.9869**
AVGAS	1.0000	.9301**	.9580**	.7625**	.7829**	.9256**
GNP	.9301**	1.0000	.9935**	.5770	.5883	.9806**
GNPDEFLTR	.9580**	.9935**	1.0000	.6130*	.6277*	.9877**
TBILL	.7625**	.5770	.6130*	1.0000	.9894**	.5658
PRIME	.7829**	.5883	.6277*	.9894**	1.0000	.5744
MOCOSTS	.9256**	.9806**	.9877**	.5658	.5744	1.0000
[illegible]	.9922**	.9615**	.9827**	.7180*	.7318*	.9614**
[illegible]	.9876**	.9686**	.9879**	.7003*	.7134*	.9712**
[illegible]	.4206	.3898	.4210	.5673	.5624	.4839
[illegible]	.3094	.1732	.2311	.5725	.5695	.2797
[illegible]	-.6609*	-.8148**	-.7739**	-.1996	-.2074	-.7420*

N of cases: 14 1-tailed Signif: * - .01 ** - .001

CORRELATION MATRIX (CONTINUED)

Correlations:	FUELHP	TOT	FPLANS	PBRIEFS	ACCONT
SEP	-.7700**	-.7641**	.2210	.3218	.8446**
SEPS	-.2441	-.2347	.7332*	.7549**	.6373*
UNITS	.9144**	.9239**	.2159	-.0070	-.8846**
MUIL	-.7228*	-.7235*	.2465	.3875	.8630**
TURBO	.4067	.3944	.7747**	.8210**	.2096
JET	.2560	.2383	.6735*	.7787**	.3699
TOTUNITS	-.7475*	-.7433*	.2507	.3618	.8571**
BILLINGS	.6845*	.6763*	.8184**	.7931**	-.0658
AVGPRICE	.8808**	.8873**	.0788	-.1338	-.9206**
STUDENTS	-.7567**	-.7522**	.1224	.2202	.8111**
HOURS	.7679**	.7680**	.8775**	.7908**	-.2120
STINGPS	.3929	.4069	.8741**	.6835*	-.0777
LOCOPS	-.6525*	-.6462*	.3359	.3842	.7565**
TOTOPS	-.1089	-.0967	.7459*	.6516*	.3708
HOUSINDX	.9888**	.9922**	.3982	.2207	-.7722**
INSINDX	.9371**	.9476**	.3923	.1632	-.8077**
DISPINC	.9681**	.9748**	.3916	.1814	-.8106**
PCINC	.9713**	.9779**	.4121	.2043	-.7978**
AVGAS	.9922**	.9876**	.4206	.3094	-.6609*
GNP	.9615**	.9686**	.3898	.1732	-.8148**
GNPDEFLTR	.9827**	.9879**	.4210	.2311	-.7739**
TBILL	.7180*	.7003*	.5673	.5725	-.1996
FPIMP	.7318*	.7134*	.5624	.5695	-.2074
MOCOSTS	.9614**	.9712**	.4839	.2707	-.7420*
FUELHP	1.0000	.9993**	.4431	.3032	-.6957*
TOT	.9993**	1.0000	.4508	.3013	-.7053*
FPLANS	.4431	.4508	1.0000	.9270**	.1275
PBRIEFS	.3032	.3013	.9270**	1.0000	.3883
ACCONT	-.6957*	-.7053*	.1275	.3883	1.0000

N of cases: 14   1-tailed Signif: * - .01 ** - .001

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